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Vol. XXVI.]
No. 655.]

JUNE 13, 1890.

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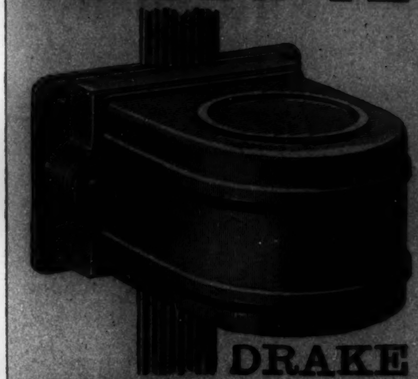

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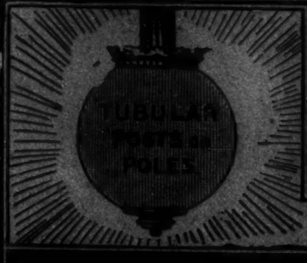

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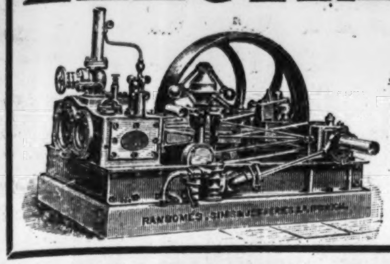
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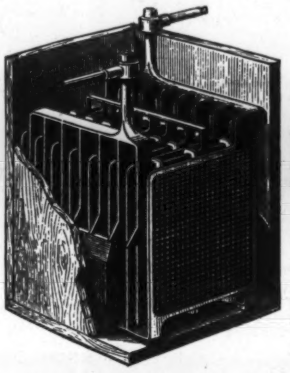

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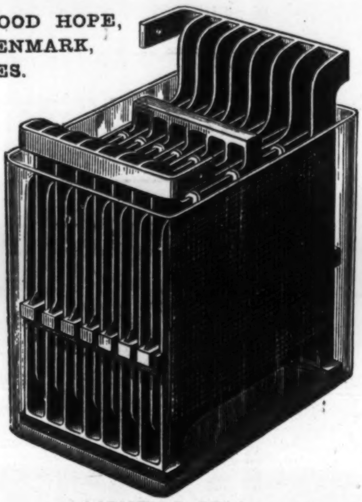

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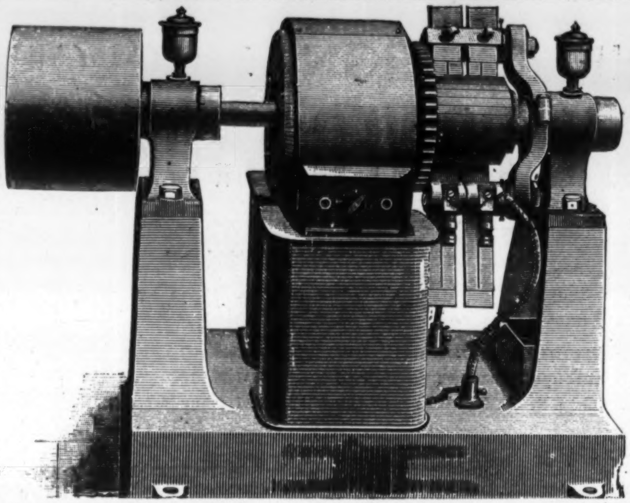

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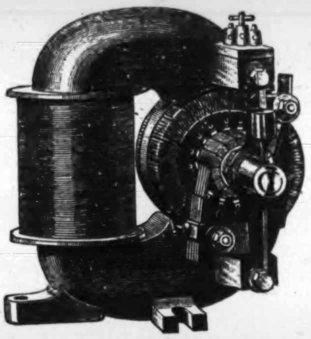

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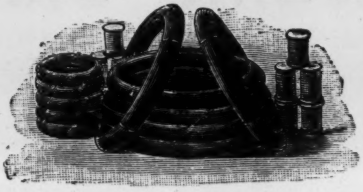

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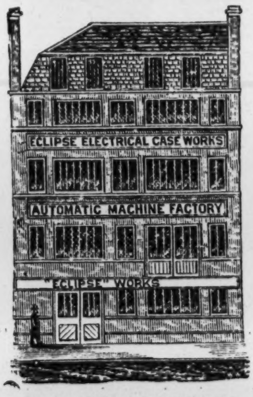

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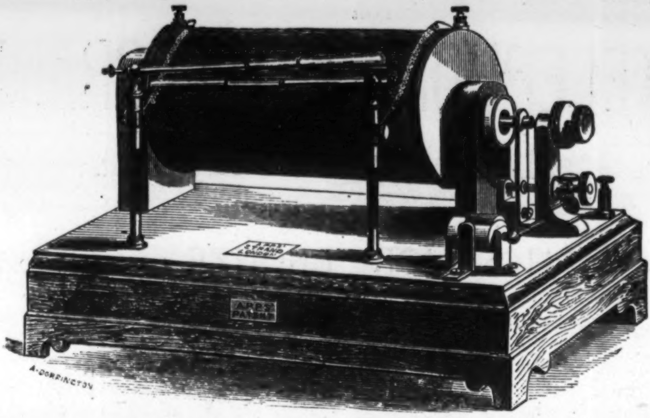

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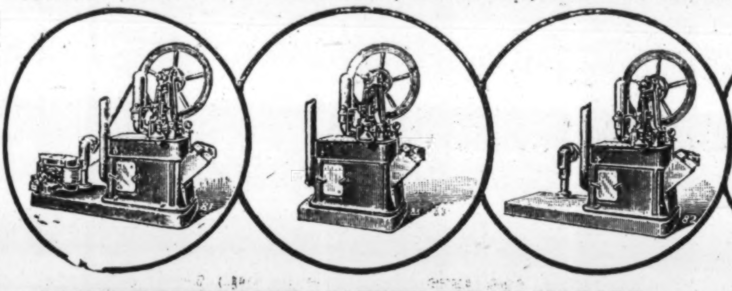

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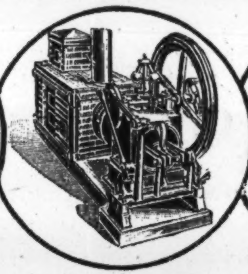

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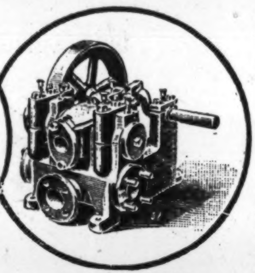

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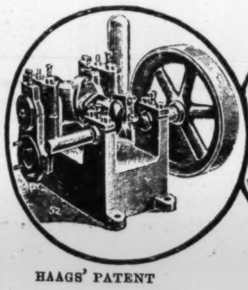

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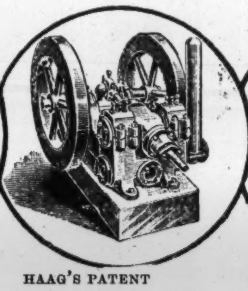

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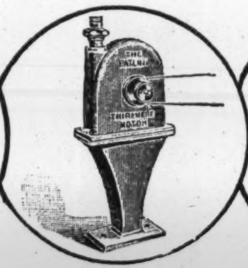

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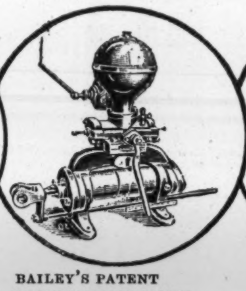

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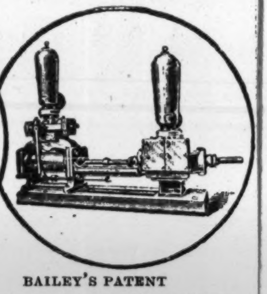

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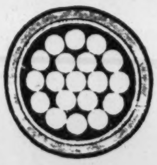

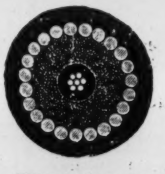

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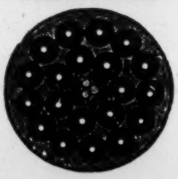

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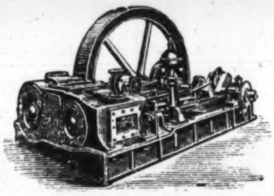

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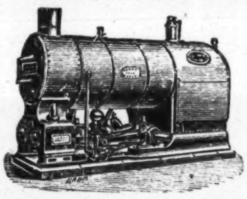

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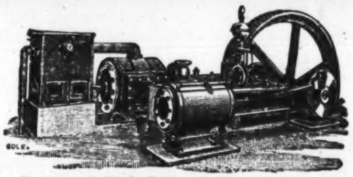

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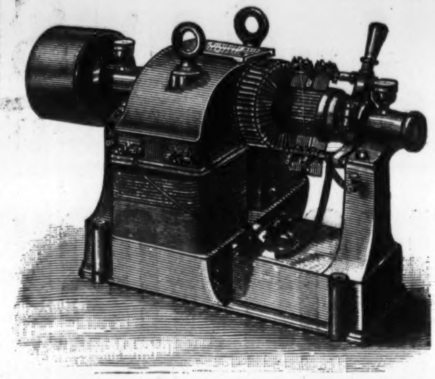

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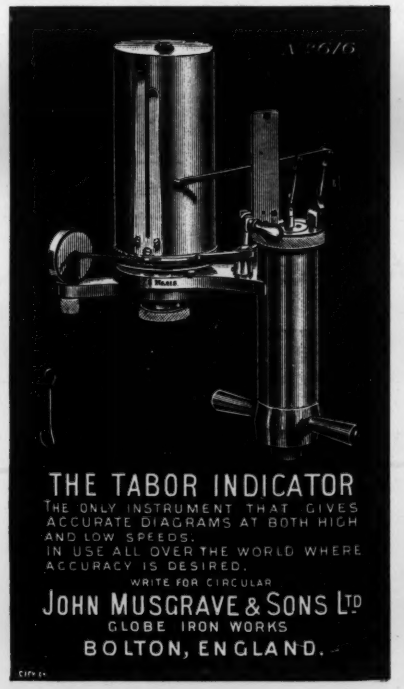

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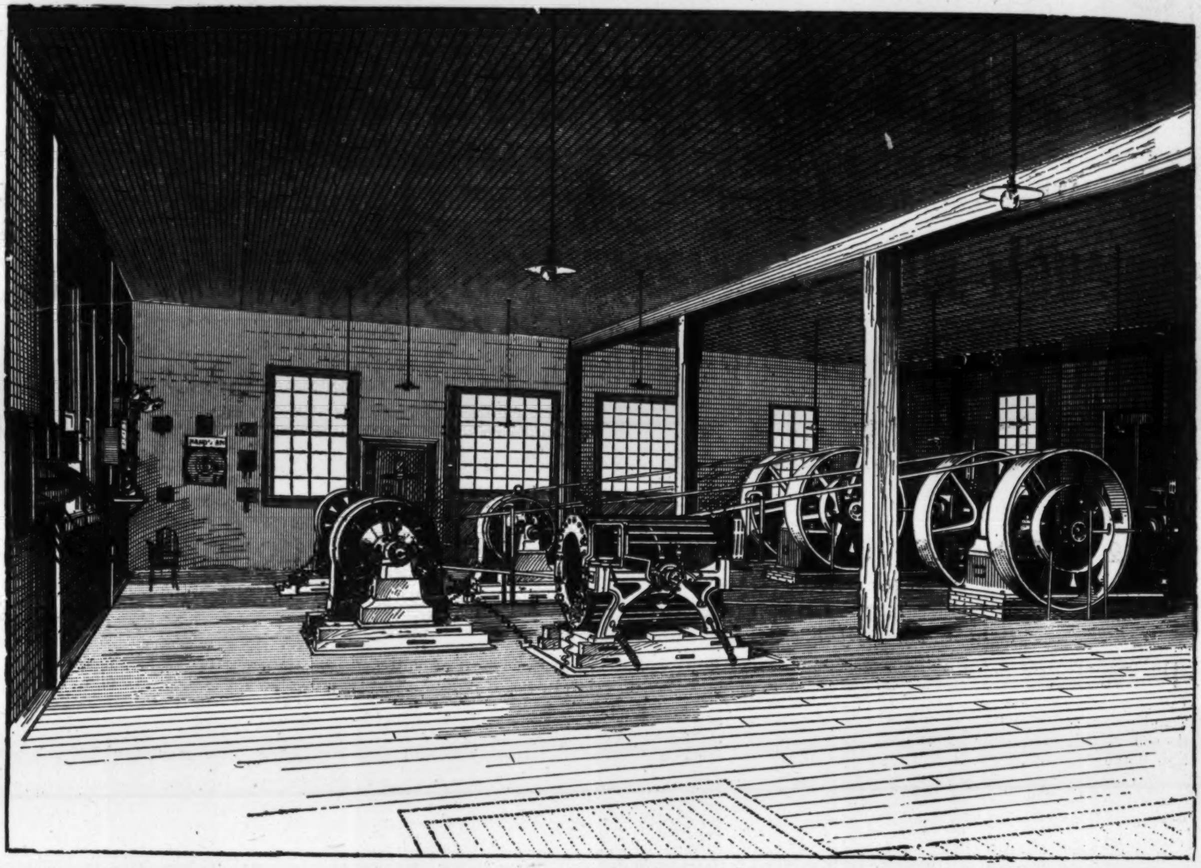

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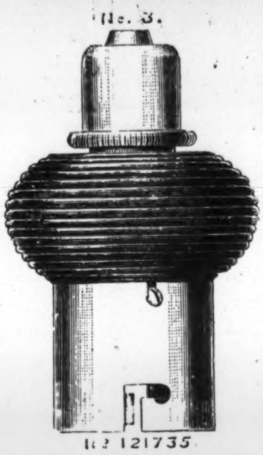

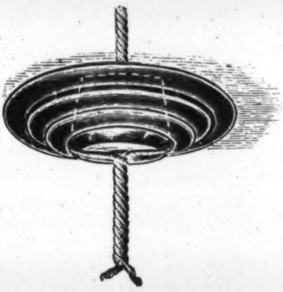

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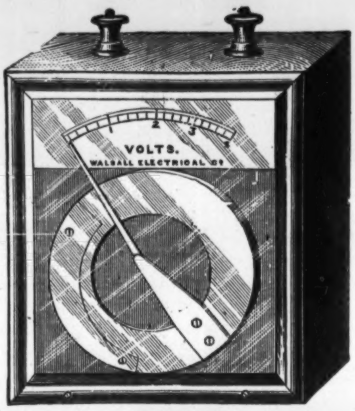

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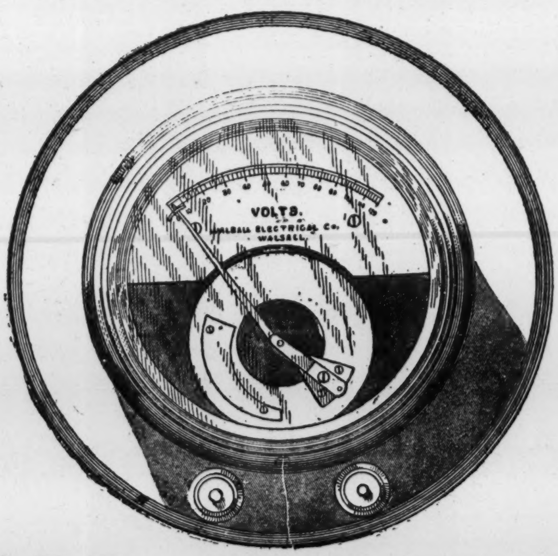

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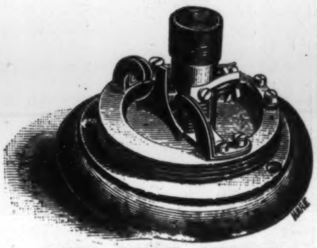

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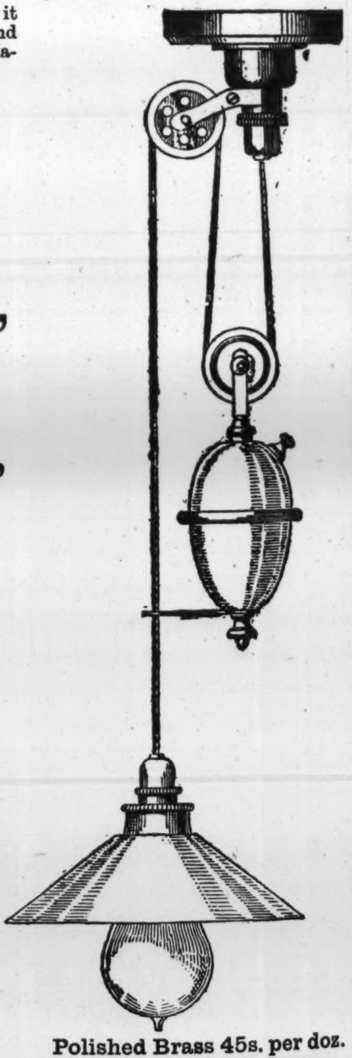

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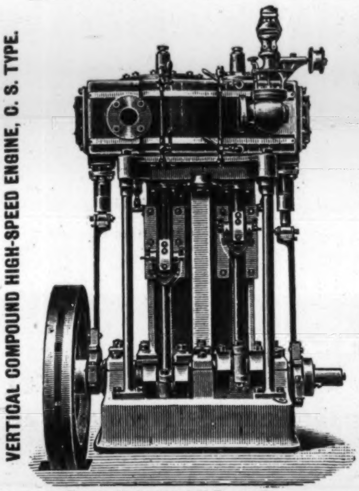

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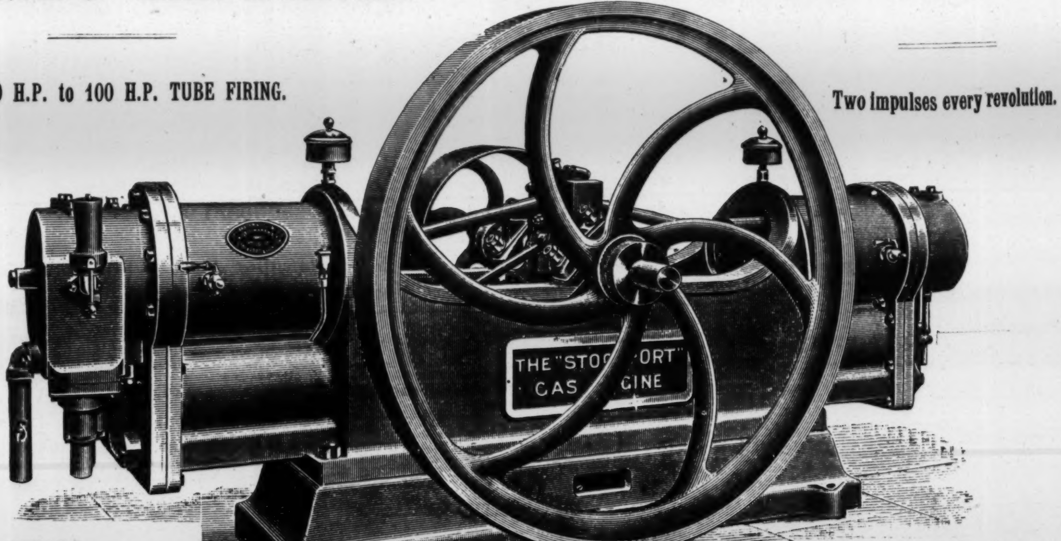

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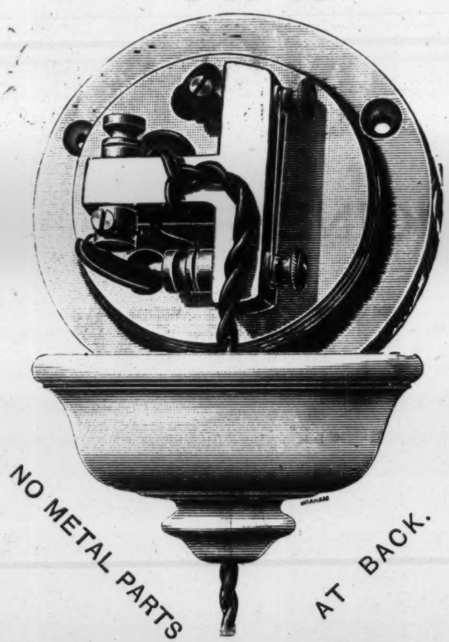

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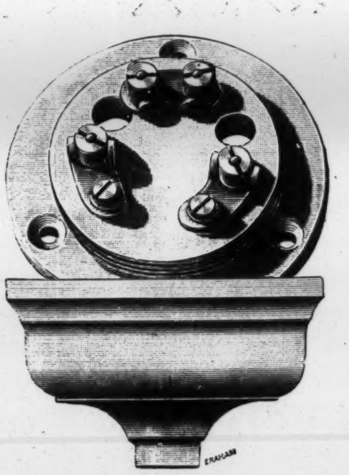

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THE TELEGRAPHIC JOURNAL AND
ELECTRICAL REVIEW.

VOL. XXVI. JUNE 13, 1890. No. 655.

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THE STRATFORD FIASCO.

THE case which terminated in the Court of Queen's Bench on Monday last, ended a lamentable chapter in the history of electric traction. The story of the ill-starred Elieson Company has been familiar for some time to many of our readers, and for those not conversant with its vicissitudes, the evidence given in the law courts last week and this has filled in the blanks in the narrative. Several years ago the company, which, in 1887, became the Elieson Electric Company, was formed to purchase Mr. Elieson's patents for electric accumulators, and for gearing to electrically propel tram cars. Mr. Elieson's idea at the first was to make no change in the rolling stock of the various tramway companies, but to use existing cars, and substitute for the pair of horses a hauling electric engine fitted with motor and gearing complete, and carrying its own set of accumulators. Experimental engines were built, numerous experiments were made, the directors presumably were satisfied, and they decided to apply the system to tram haulage on a working scale. The company was fortunate enough to come to an agreement with the North Metropolitan Tramways Company for running on a section of line being then constructed between Stratford and Manor Park. A better piece of line could not have been obtained. There were no gradients to speak of, and the thoroughfare was not a busy one. The motors and gearing for six new engines were ordered from a well-known electrical firm, while the necessary accumulators were put in hand to be made at the company's own workshops. The use of part of the tramway depôt at Stratford was obtained for a charging station, and steam engines and dynamos were laid down. The section of line was being pushed towards completion, and everything seemed to be going well with the new company. In time the electric engines were delivered, and many successful runs of an experimental character were made on the line in the dead of night and in the early morning, when the company had uninterrupted possession of the line. At first, two electrically-hauled cars only were to run taking their turn alternately with the horsed cars, and a day was fixed for the systematic running to commence. From that day dates the misfortunes of the company.

We need not describe the Elieson gear, as it has been referred to in our columns more than once. The method of reducing the speed from the motor to the driving axle is ingenious, and a gear properly designed on the inventor's idea would doubtless work well. But in the design of the experimental engines the idea was not well carried out, nor in the six new ones constructed in accordance with the inventor's directions were many improvements made. The material was not employed to the best advantage, and that necessarily meant increased weight both live and dead. However, during the experimental running the engines worked well, and it was in an attempt to improve the design that the misfortunes first arose. The motor as a whole had to rotate, and obviously it was of advantage to have it as nearly balanced as possible. In order to get nearer a balance the inventor decided, just before the systematic running commenced, to lengthen the armature spindle, and to move one of the bearings farther out, attaching this bearing to the field magnets through the medium of a gunmetal bracket instead of directly, as hitherto. The result of this was that the spindles sprung and broke the connections to the commutator, being too weak for the increased length between the bearings and the additional flexibility introduced by the intermediate bracket. The remedy for this trouble was simple, and could have been carried out either by making new spindles of larger diameter, which could not spring, or by retaining the spindles and making the connections flexible enough to remain uninjured by the springing. At these accidents the company took fright, however, and the work was taken out of the hands of the constructors before they distinctly realised the cause of the injury.

Armatures with stronger spindles were constructed by other engineers, and, we believe, all went well for about eight months and over 40,000 miles were traversed with two cars, and 400,000 passengers carried. Extension was determined upon, and a new charging station was to be erected at Plashet, near the other end of the line. The extension being settled, the whole of the arrangements of the new station and the management of the subsequent running was given into the hands of the engineers to whom the company fled in its former fright.

It was supposed that all trouble would now be at an end. The station was to be arranged under skilled supervision, and the engines were to be thoroughly overhauled while the station was being got into order. When the works were completed the electric engines would come forth, and difficulties and breakdowns would be, of course, things of the past. How very different from these rosy anticipations were the results. By order of the North Metropolitan Tramways Company the running was, after the occurrence of several catastrophes, discontinued, and against the claim of Crompton & Co., who had charge of the works, and who sued the Elieson Company for certain moneys due to them, a counter-claim was entered for £10,000, as damages for injury to business and reputation, caused by alleged negligence. Fortunately we have not to give a judgment on the matter, for the case has been tried and the verdict given. But whatever be the material damage sustained by the Elieson Company, there is no doubt that the cause of electric traction has suffered much from the failure of this pioneer enterprise. No scheme had a better chance of success; no enterprise has ended in a more miserable fiasco. Badly managed from the first, the natural consequence has followed, and where success ought to have been achieved irreparable failure has resulted. Whether another chapter of this unfortunate company's history remains to be written we do not know, but on account of all concerned we sincerely regret to have to chronicle so sad a tale.

It would not be fair, however, to close these comments without a word in favour of the inventor, and we do not think we can serve him in a better manner than by quoting the remarks made by Prof. Silvanus Thompson during the discussion of Mr. Reckenzaun's recent paper on "Electric Traction Data," read before the Old Students Association, although we do not in the least approve of the Professor's altogether uncalled for and indiscreet manner of criticising Elieson's successors:—"As long as Mr. Elieson was in charge of those cars they ran extremely well, and they had very few troubles of any sort whatever; but the thing went out of his hands and passed into the hands of another firm of engineers—engineers, mind. They were supposed to be competent engineers; and lo and behold, the very first day they took the management of the thing they spoilt two engines by running them over points, the points being so misarranged that the two wheels took two separate lines and branched out one from the other. They also managed to ruin another engine by tearing the teeth out of the driving arrangements. Hornbeam teeth, properly set, ought not to have come to grief. It was a purely mechanical breakdown, due partly to the fact that the people who were running the cars did not understand, and had not taken pains to master, one very simple electrical arrangement which Mr. Elieson had introduced. Mr. Elieson had introduced a second switch to turn on a small current for the starting up of his motor before he threw it into gear. Then he had a big switch to turn on the big driving current. 'Well,' they said, 'this is unnecessary—we will have one switch only which will be simpler to manage, and we will have the big switch.' They put on the whole of the current, and got an enormous speed on the motor, and then ran it into gear, and the first time it was put into gear off went the teeth of the gear. Purely a mechanical breakdown, not an electrical thing at all. A system which had worked excellently for nine months of experimental trial under Mr. Elieson broke down in three days when the working was given over to the contracting firm of engineers! When people said electricity did not do for driving tramcars, and pointed to the North Metropolitan failure in support of their argument, they had simply to remember that it was not an electrical breakdown at all; it was a purely mechanical one, which good engineering might have avoided." It is almost a pity that the scheme cannot be revived with Prof. Thompson as the man at the wheel.

The Pace that kills. "As quick as lightning," is a phrase colloquially used to express the maximum of rapidity. But according to a contemporary, electricity itself is outstripped by that old-fashioned machine the human body, by which it appears power can, so to speak, be generated in the brain, transmitted through the nerves and developed in the muscles in an infinitesimal fraction of a second. It is stated that a pianist, in playing a presto of Mendelssohn, played 5,595 notes in four minutes and three seconds. The striking of each of these, it has been estimated, involved two movements of the finger, and possibly more. Again, the movement of the wrists, elbows, and arms can scarcely be less than one movement for each note. As 24 notes were played each second, and each involves three movements, we would have 72 voluntary movements per second. Again, the place, the force, the time, and the duration of each of these movements was controlled. All these motor reactions were conditioned upon a knowledge of the position of each finger of each hand before it was moved, while moving it, as well as of the auditory effect to force and pitch, all of which involves at least equally rapid sensory transmissions. If we add to this the work of the memory in placing the notes in their proper position, as well as the fact that the performer at the same time participates in the emotions the selection describes, and feels the strength and weaknesses of the performance, we arrive at a truly bewildering network of impulses, coursing along at inconceivably rapid rates. Such estimates show, too, that we are capable of doing many things at once. The mind is not a unit, but is composed of higher and lower centres, the available fund of attention being distributable among them.

Steam v. Electricity

AMONG the several interesting papers read before the American Institute of Electrical Engineers, during the last meeting at Boston, was one "On the Limitations of Steam and Electricity in Transportation," by that indefatigable writer on the subject of electric traction, Mr. O. T. Crosby. The author commences with the question "Do you expect electric engines entirely to displace locomotives on all railroads ?" He goes deeply into comparative figures and presents most elaborate tables and diagrams with a view of answering the question in the affirmative, limiting his assertions to special cases. Thus "for speeds above 70 miles per hour, an electric motor of 90 per cent. efficiency, working through gearing of 90 per cent. efficiency, would prove more economical than the steam locomotive, save in cases of very infrequent service on very long lines." According to the author's calculations a loss of about 40 per cent. in the electrical system is the best record that can be expected with our present knowledge of the subject. At speeds of 100 miles per hour and upwards, neither steam at its highest efficiency, nor electricity at 60 per cent. efficiency is commercially practicable. The paper teems with practical suggestions and it clearly defines possibilities under existing circumstances, which could only be altered by entirely new discoveries.

Electric Street Car Motors.

"MAGNETIC Data of the Sprague Street Car Motor" formed the subject of a paper by Mr. H. F. Parshall, of New York. The author, at the outset, apologises for the incompleteness of the figures, and we rather regret this fact because it is seldom that reliable data on motor design is forthcoming. The ratios of the lines of force through various parts of the magnetic circuit to the lines of force through the armature are given as follows :—

$$\frac{\text{Lines through magnet}}{\text{Lines through armature}} = 1{\cdot}45$$

$$\frac{\text{Lines through middle of yoke}}{\text{Lines through armature}} = 1{\cdot}27$$

$$\frac{\text{Lines through middle pole piece}}{\text{Lines through armature}} = {\cdot}666$$

The author states that "in order that these ratios may remain constant in the same type of machine, the ratios of the magnetising force in the one part of the circuit, to the magnetising force in the other parts, must also remain constant."

Electric Light Engine Refuse.

AN important question concerning not only hotel proprietors, but others using the electric light with engine power, was decided in the Queen's Bench Division last week. The proprietors of the Hotel Mêtropole, London, which is rated at £20,000 gross, called upon the Vestry of St. Martin's-in-the-Fields to remove the refuse of the hotel, amongst which was a considerable quantity of clinkers produced by an engine used for working the lift and electric light machinery. The Vestry declined to remove these clinkers without payment, on the ground that they were trade and not domestic refuse. The Bow Street Magistrate decided against the Vestry, and the Court has now upheld the Magistrate's decision and dismissed the suit of the Vestry Their lordships, however, gave the Vestry leave to appeal. As several important hotel and other installations are situated in this district it is most likely that the Vestry will do so, but as the electric light is now looked upon as so great a necessity in large hotels, its use in such circumstances cannot be for "trade" but for comfort and necessity, so it is not too much to expect that in any further appeal the present decision will be maintained.

Technical Education.

IF some of the natural philosophy professors, now in their graves, were to be resuscitated and were taken round some of our technical institutes they would, we believe, be much surprised, not so much perhaps at the vast onward strides which have been made since their time, supplementing the knowledge which they themselves taught, as at the complete changes in the methods of teaching which have taken place. The narrow grooves in which they worked, perhaps unavoidably, have been departed from and technical instruction, as distinct from theoretical, is no longer considered, as it practically was, to be fit only to be given to workshop apprentices. The happy combination of the practical and the theoretical as exemplified in the City and Guilds and other similar institutes and colleges is beginning to tell, and will tell still more in the future. The ponderous theories, which however much they may show the power of a man's brain, are, nevertheless, of small value, if they cannot be applied to practical uses, will now be guided to serve useful purposes, and will not run partially to waste as they did in ancient times. Whatever the training, it should never be forgotten that its object should be not merely to prepare the student to pass examinations, but solely to train him for his future career in life.

The Column Printing Telegraph Company, Limited.

WE have received a copy of the prospectus of this company, which was issued on Wednesday last, and the list of which closes to-day. The capital is to be £100,000, and the present issue is of 50,000 shares of £1 each ; 10,000 as part payment of the vendor and 40,000 for subscription of the public. Besides the £10,000 in shares, the vendor is to have £20,000 in cash ; the £20,000 remaining of this issue will therefore be the available working capital of the company. It is estimated that if "only 500 machines are rented, ... a return of not less than 15 per cent. on the capital invested may be reasonably anticipated." The invention to be worked by this company we have already described in the REVIEW, the special feature of it being the printing in type on broad sheets, instead of on long tapes, a manifest advantage in many instances. In the prospectus may be seen a specimen of the work done by the machine and also a letter on the subject of the invention from Sir William Thomson ; the former is good and the latter is exceedingly favourable. To us the purchase price, although not large as such things go, seems somewhat so compared with the working capital, but we agree with the statement in the prospectus as to a good profit being probably realisable on a comparatively small output of machines. On the board of directors are some good names and with careful management we see no reason why the company should not prove a great success, especially as it will have an advantageous mutual arrangement with the already existing Central News, Limited.

AUTOMATIC ELECTRICAL CALL-BOX.

THERE is not the slightest doubt that when the telephone monopolies in this country have expired considerable impetus will be given to the industry. One direction in which development is sure to take place is the establishment in railway stations, and other public places, of telephone call-boxes by means of which, on the payment of a fixed sum of money, the exchange may be called, and communication thereby made with one's friends. A large number of call-boxes of this kind are erected in shops, railway stations, &c., in the United States, an attendant being employed to receive the money from persons using the telephone. It has, however, been found that the telephone companies have been greatly defrauded by the call-box employés; and, in order to prevent such embezzlements, one of the American companies is about to introduce an automatic electrical call-box.

Last month we had an opportunity of inspecting the first call-box of this kind. It was made in London, and has just been shipped to New York. The electrical part of the apparatus is of the usual type, consisting of battery, transmitter and receiver, whilst the automatic portion is made on a somewhat similar principle to that of the ordinary automatic penny-in-the-slot machines for sweets, cigarettes, &c. There is, however, this difference, it is possible to obtain the return of one's money if the line is broken, or if, after putting through the slot the necessary coins, it is not desired to communicate by telephone. This will subsequently be evident. In the apparatus in question, to call the exchange it is necessary to put through the slot 15 cents, either a dime (ten cents) and a five cent piece, or three five cent pieces, but only these two combinations will permit of the exchange being rung up. This arrangement may, however, be modified. After inserting the money, a button on the right hand side of the box must be pushed, and this completes an electrical circuit, and calls up the exchange, when conversation may take place. At the same time the money is caused to fall into a receptacle placed on the right hand side at the bottom of the box. If, however, after putting the money through the slot it is not desired to call the exchange, or if the line be broken, the money is returned to the individual wishing to communicate on his lifting the receiver off the switch. This action causes the money to fall into a tray projecting from the left hand side at the bottom of the box, when the cents may be picked up.

The apparatus is rather complicated, but notwithstanding this it worked satisfactorily on the occasion of our visit. As the inventors have not yet protected this call-box, technical details are not forthcoming at present, but further information regarding this ingenious apparatus may be looked for in the course of this year, when the system will be brought before the British public.

THE EXPLORATION OF MAGNETIC FIELDS BY MEANS OF TUBES OF RAREFIED GAS.

THE influence exerted by magnetic fields upon rarefied gases has from time to time received much attention. Amongst the many physicists who have studied the interesting phenomena which are due to such influences the following are at once suggested, namely, Plücker De la Rive, Trève, Daniel, Le P. Secchi, Chautard, Crookes, Goldstein and Boltzmann. They have described and variously commented upon the luminous phenomena which are observed in tubes of the Geissler type which have been placed within the influence of a magnetic field.

One of the facts upon which all observers have been fairly unanimous in their description is, that when a tube containing rarefied gas is brought within the sphere of influence of a magnet, an increase in the degree of electrical resistance is produced.

The investigations of those scientists whom we have named, have been chiefly of a *qualitative* character; however, they have so added to our knowledge of these phenomena that they are now ripe for *quantitative* investigation.

Amongst those physicists who at the present time have been engaged in the study of this subject, Mons. A. Witz must be especially mentioned, and it is to a recent communication of his to the Academy of Science, at Paris, that we wish to direct the attention of our readers.

Mons. A. Witz has been especially devoting himself to the measurement of the intensity of the magnetic fields, the difference of potential between the electrodes of the tubes of rarefied gas, and the intensity of the electric current which was made to traverse these tubes.

In these experiments a fine electro-magnet, specially made by Ducretet, was used, of such a strength that it was possible to obtain with it a magnetic field of from 100 to 14,000 units.

The intensity was determined by observing the rotation of the plane of polarisation in carbon bisulphide. Between the poles of the magnet were placed either Geissler tubes or a cylindrical tube of 20 mm. diameter, having movable electrodes such that it was possible to vary their distance and also the pressure of the gas within it; the tube experimented upon was excited with a Rhumkorf coil. Into the induced circuit a galvanometer was introduced which had to be placed at a distance of nearly 35 m. from the electro-magnet in order that the latter might exercise no appreciable influence over it. The intensity of the induced current, which was always full, was estimated in milliampères.

In order to estimate the difference of potential between the electrodes of the tube, a sparking micrometer was employed; when the sparks were passing continuously at the same time in the tube and in this micrometer, it was assumed that the differences of potential were equal. It will at once be recognised that this method is really an adaptation of one originally employed by Faraday, and applied by Schultz to the study of the electrification of tubes containing rarefied gas.

Whilst measuring simultaneously the intensity of the magnetic field and that of the difference of potential between the two electrodes, Mons. Witz arrived at the conclusion that this difference of potential increases with the intensity of the magnetic field; but for a given field and tube, the difference is independent of the intensity of the discharge.

In order to demonstrate this, the following are some specimen figures extracted from Mons. Witz's laboratory note book; they refer to a tube containing air situated in a uniform magnetic field influencing almost its entire length :—

	Intensity		Difference of potential in volts.
	Of the field in C.G.S. units.	Of the current in milliampères.	
(*a*)	0	4·12	1,860
(*b*)	2,200	2·58	2,781
(*c*)	3,200	2·39	4,146
(*d*)	4,300	2·20	5,064

In these experiments the intensity of the "inducing" current remained constant, and the influence of the magnetic field created, as it were, a resistance to the flow of the electricity. To maintain the intensity of the "induced" current constant it sufficed to increase the "inducing" current, and the difference of potential was not perceptibly raised.

This phenomenon is exhibited in the case of each of the ordinary gases but, as might be supposed, to a variable extent. It appears to be most marked in the case of these gases, of which the spectrum is most modified whilst under the influence of the magnetic field. And it varies with the conditions of the tube.

If the experiment be carried on between circular poles of 20 mm. diameter, it can be proved that different points of the tube are not equally sensitive, so that in exhibiting the effects obtained with a tube containing bromine vapour, it is desirable to cause the tube to move between the poles.

The following are typical results :—

Field.		Intensity of current	Difference of potential.
		Milliampères.	Volts.
0 C.G.S. units		6·58	1,325
11,570 units	on the positive pole... ...	2·97	4,464
	beginning of the capillary	2·62	4,964
	middle	3·35	3,780
	end	2·80	4,935
	on the negative pole ...	2·25	3,066

The maximum effect is produced at the ends of the capillary tube on the same side as the positive pole : it is greater at the positive pole than at the negative pole.

The same has been observed for fluoride of silica, but the action is the reverse in the case of air.

Whatever the position of the tube in the field may be, it is always observed that the current is displaced according to the laws of electro-magnetism. The tube being arranged so that it cuts across the lines of force the luminous thread which traces the course of the current is thrown to one side. When the tube is placed as it were paralled to the lines of force the luminous thread proceeds in a straight line from one electrode to the other. If the tube be laid upon one of the poles of the magnet the luminous thread appears to have the form of an S, being turned towards the right by one pole and towards the left by the other—phenomena which might be foreseen from what has already been stated.

Mons. Witz noticed one exceedingly curious phenomenon which appears to be quite new, and which can be taken advantage of with good results in the exploration of the magnetic field. When the tube is carried into the magnetic field, it is observed that the appearance of its poles changes according to the intensity of that part of the field which it then occupied. A bluish disc appears, which changes its position and appearance as the tube is moved about in the field in such a way that the direction of the lines of force in the field become actually visible to the eye. This phenomenon must be seen before it can be properly appreciated, and, without having it to appeal to, it becomes a matter of great difficulty to give any intelligent verbal description of it.

This phenomenon is shown with great brilliancy if *small* tubes filled either with chlorine, bromine vapour, hydrogen, or fluoride of silica are employed, and Mons. Witz states that it can be used with great accuracy in the exploration of intense magnetic fields.

CENTRAL LABORATORY OF THE SOCIÉTÉ INTERNATIONALE DES ÉLECTRICIENS.

(*Concluded from page* 603.)

Standardising Ampèremeters.—The current is produced by a battery of accumulators, the method of coupling which is capable of variation. The intensity is regulated by rheostats composed of a great number of movable German silver rods whose extremities are immersed in mercury cups. The current traverses the apparatus and a resistance at the terminals of which the potential is measured.

For standardisings not exceeding 10 ampères the resistance employed is the 10th of an ohm in German silver, at the terminals of which the difference in potential is measured in volts by means of a Deprez-d'Arsonval instrument, mounted as a voltmeter.

For intensities betwixt 10 and 100 ampères, we adopt for a rheostat a strong rod in German silver of about 2 mm., upon which move two potential slides. A Deprez-d'Arsonval galvanometer is attached to these two slides, the position of which is so regulated that the indications read from the galvanometer scale express directly the number of ampères traversing the rod. This standard is taken from time to time by comparison with an ampèremeter standard. Thus mounted the galvanometer constitutes our third class standard of intensity corresponding to the voltmeter described in the preceding paragraph. The possible error in the reading is less than 1 in 100.

Lastly, for currents of very great intensity between 100 and 600 ampères we make use of grid-shaped rheostats of very low resistance (one or two ten-millionths of an ohm), the resistance of which has been measured with every possible care, and the difference in potential at the terminals is measured with a very sensitive galvanometer.

The electro-dynamometers, like the ampèremeters, are standardised by means of continuous currents.

Electricity-meters.—Continuous current meters are easily standardised, since we possess standardised ampèremeters and voltmeters. These need only be supplemented by a good watch. Ordinarily we make use of Deprez-Carpentier mirror ampèremeters and voltmeters, which we have classed as standards of the second order. We have not yet adopted automatic registration for these measurements. An observer is told off to the measurements and takes note of all the variations of the current. Moreover, the employment of good accumulators makes the registering very easy.

As regards alternating current meters, we do not undertake standardising unless the meter is constructed for use with such a number of alternations as one of our machines is capable of furnishing exactly. Our measuring apparatus is a Carpentier electro-dynamometer.

Testing Engines.—Our installation for this purpose is incomplete. It will only be so until we have left the Place Saint-Charles. We found it extremely difficult to place an engine in favourable conditions for testing when it happens to be of any bulk, and the arrangement of our transmission is unfavourable to our obtaining variable speeds.

Determinations of yield, in the case of engines of more than 2 or 3 horse-power, cannot be carried out at the laboratory with the requisite exactness. We are constrained to measure with the brake the mechanical force developed in the transmission shaft, and, by way of change, after restoring the motor to like conditions of working, deduce therefrom the power transmitted to the machine. This method of proceeding is wanting evidently in exactness, and can only obtain for us more or less approximate data.

Other interesting processes, *i.e.*, determination of characteristics, measurement of E.M.F., of the resistance, cold or hot, of divers circuits, &c., are carried out without difficulty.

Our third class voltmeter and ampèremeter are especially useful for this species of determinations, they enable us to measure at all times with all desirable exactness, and without calculation, the current's intensity and the difference in potential at the terminals. The rheostats employed for this purpose are composed of sets of incandescent lamps.

In the peculiar case of the engine to be tested being a small sized motor of 2 to 3 H.P. the yield may be measured without very much trouble. The machine is put in motion as a receiver and the mechanical force developed is measured upon its pulley with a small sized brake having a weight or spring. The exactness of the measurement easily attains to 1 per cent.

Alternating Current Machine.—The electric work is measured with an electro-dynamometer and a Carpentier aperodic electrometer.

Testing Batteries.—The constants to be determined are the E.M.F. and the internal resistance. It is indispensable, also, to take into account the duration of the element. The E.M.F. is measured by Pellat's method. The internal resistance, which is an ill-defined quantity varying with the intensity of the rendering, is determined by the loss of potential at the battery terminals at the moment when the latter commences to give out the normal current. We show upon the certificate how the resistance has been measured.

As regards the duration of the battery, this is tested by two different methods, accordingly as the element may be destined to furnish an intermittent force (telegraphy, telephony) or a continuous one (lighting, accumulator charging). In the first case the battery is exhausted by discontinuance. An automatic apparatus driven by an electric motor allows the current from the battery to flow at regular predetermined intervals, during a predetermined period, through a suitable resistance. Daily or weekly an operator measures the E.M.F., and the element's resistance and the variation curves of these quantities are marked upon the certificate.

If the battery to be tested is for continuous work, it is connected to a known resistance at its normal output, and the difference in potential is measured daily at the terminals of this resistance. The certificate shows the E.M.F. with open circuit at the commencement, and the variation curve of the difference in potential during the rendering.

Testing Accumulators.—Ordinarily the experiments we carry out with accumulators are predetermined by the party interested. We inscribe the results upon the certificate without deducing therefrom any conclusion regarding the yield or the work of the apparatus. Should the party interested not lay down any programme, we charge the accumulator several times in the ordinary course, arresting the charge when the dfference in potential at the terminals reaches 2·5 volts, and we make a certain number of discharges at different rates, arresting the discharge directly the difference in potential falls below 1·8 volt. We show the charge and discharge curves in the certificate ordinarily in ampère hours. We indicate at a certain number of points the concordance of the E.M.Fs., so as to facilitate the tracing of the curves into watt hours.

The Constants of the Wires.—A metallic telegraphic or telephonic wire ought to be tested from the two-fold standpoint of its conductivity and its mechanical strength.

To determine its conductivity the electric resistance is measured by a length of the wire, the geometric dimensions of which are known. This measurement is made with extreme exactness by means of a Wheatstone bridge. The length is determined by winding the wire about a large ebonite cylinder, the radius of which is perfectly well known, and by counting the number of spiral revolutions. The diameter is the most difficult to determine. It may be got by weighing a known length of the wire and dividing the result by the density and the length. We find it much more convenient and quite as exact to measure the diameter directly by means of M. Dumoulin-Fromont's excellent callipers.

By taking the precaution of recommencing the measurement a score or so of times at different points of the wire and in different directions around a single point, the average result is sufficiently exact and ensures to the determination of the wires conductivity an approximation of at least 1 per cent.

The certificate shows the kilometric resistance of the wire at a certain temperature and the mean diameter of the wire. At the request of the party interested, we also show the conductivity of the wire relatively to that of the Matthiessen pure copper at the temperature employed for the experiment.

The tensile strength is obtained by suspending a balance beam to the wire and bringing about the rupture by the addition of weights. We likewise indicate the permanent elongation per metre at the time of rupture, and also the number of bends it will bear when twisted and untwisted alternately round a rod of a given radius.

Cable Constants.—The electric capacity of a cable is easily measured, if one is taken sufficiently long, by means of a ballistic galvanometer and a standard condenser. The test of insulation is made as may be desired in air or in cold or hot water. If the cable is only slightly insulated the measure of its insulation is very easily made by means of a Wheatstone bridge, capable of measuring resistances of from 300,000 to 400,000 ohms.

Supposing the cable to be well insulated and to be of sufficient length, we determine by means of a very sensitive Thomson galvanometer the deflection produced by a current through the dielectric from a battery of 200 Callaud cells. This method is employed in the testing of submarine cables.

When we are asked to determine the insulation of a very short length of cable, or of a small quantity of some insulating material, we make use of a Mascart electrometer, applying the loss of charge method.

Photometry.—Our standard of light is a carcel lamp consuming 42 grammes of colza oil per hour. A Dumas balance regulates the combustion during the experiment. We possess two of these standards and frequently compare them together.

The photometer used in the majority of our measurements is a simple grease spot Bunsen. It ensures great exactness in testing incandescent lamps. The colour of the radiations shown by these lamps is in fact almost that of the carcel lamp, and the difference in intensity between the two sources is not excessive, it enables us to answer for a less error than 2·5 per cent., which in photometry may be considered sufficient.

In testing arcs a two-fold difficulty is encountered; the difference between the tints is very marked, and the irregularity of the two intensities is, too, considerable. We are at present engaged upon an installation which is to enable us to substitute for the carcel standard another of whiter light and of nearly five times as great intensity. Moreover we have undertaken a series of experiments based upon the employment of coloured glasses, the results of which we hope will do something to increase the exactness of our measurements.

In testing an incandescent lamp we usually construct, in a well defined direction, the variation curve of its illuminating power with the electric energy supplied to it, and this curve is marked upon the certificate.

We likewise possess a Mascart photometer which gives us very good results when testing the luminous intensity apart from the intrinsic condition of the candles.

I have been silent as to the considerable number of determinations which we are asked to make from time to time, having merely wished to lay before you the principal methods we employ. Now that you are acquainted with these I will tell you what it is we are doing in addition to those continuous researches and studies, whose object is the constant verification of the standard of our apparatus and of the security of our installations.

THE WORK OF THE LABORATORY.

Manufacturers have taken to us gradually. At first, when we were but little known, they could dispense with our services, and during the first month of the laboratory's working existence, applications for tests were rare, and were mostly all of them from friends, with the object of encouraging the institution. At the present time we possess a good and solid *clientèle*, amongst whom may be counted the leading electrical manufacturers in Paris, large administrations, schools, and provincial faculties. We have even extended our sphere of work to places beyond Paris and France, and a certain number of certificates have been asked from us by clients in Italy, Belgium, Switzerland and Russia.

I am not authorised here to publish the results of determinations made by us; they are the exclusive property of those persons by whom certificates have been asked, and we are bound to them to preserve professional secrecy intact; I am therefore only at liberty to lay before you statistics of our work.

In 1888 we granted 73 certificates. In 1889 the number rose to 190, and was thus distributed :—

Testing of engines	4
Standardising of amperemeters	12
,, voltmeters	17
,, meters	18
,, condensers	1
,, resistances	4
Battery experiments	23
Accumulators ,, ...	15
Determinations of the constants of conductor wires...	58
Determinations of the specific resistance of a dielectric	3
Determinations of the conductivity and of the thermic variation of the conductivity of a substance	1
Photometric tests	9

Since January 1st, 1890, we have undertaken 23 tests, thus the total number of certificates granted up to date has been 286.

Some of these certificates were granted at the request of the jury of awards, in class 62, at the Universal Exhibition. Other and much more important undertakings, viz., experiments with dynamos, arc lamps, photometric measurements, which have not been included in the above statistics, not having called for the grant of certificates, were made in the exhibition itself, under the direction of the jury, by our staff and with our instruments.

A few physicians and manufacturers have been allowed to avail themselves of the resources of the laboratory and to make personal researches. I will merely mention Marié-Davy, Dr. Ribard, MM. Berton and Leclerc. I am not here to describe the details of their work. Possibly some day they will personally communicate to you the interesting results they have obtained.

It is unnecessary to tell you that M. Joubert has reproduced the experiments of M. Hertz at the Laboratory; some among you have not yet forgotten the interesting lecture which he delivered here on the subject, nor the brilliant experiments made by him in our great hall at the place Saint-Charles.

M. Mascart also performed an exceedingly interesting series of experiments before the Higher Commission of Theatres with reference to the danger of conflagration in theatres from the use of incandescent lamps. These, which were perfectly novel, made at the time a considerable sensation.

I conclude, now, by reminding you that there are at present six pupils in the Laboratory, and that 17 have left us after completing their studies there. These 23 are divided among the following nationalities: 15 French, 1 Belgian, 2 Norwegians, 2 Russians, 1 American, 1 Roumanian, 1 Italian. All of them were assiduous students of our work, and I feel persuaded that the greater part have derived a real profit from their study.

Of the large number of candidates, including foreigners, who apply for admission to the Laboratory, we only select such as appear to us sufficiently instructed to be able to take an active and profitable share in our work.

Such, gentlemen, is the present position of the Laboratory. I have endeavoured to lay before you a correct idea of its operations, and I am happy if I have been able to persuade you that the Society's Laboratory will be capable henceforth of rendering some service to the electrical industry.

THE EFFECT OF THE ELECTRIC CURRENT UPON FRICTION BETWEEN METALLIC SURFACES.*

By LUCIEN I. BLAKE, Prof. of Physics, State University of Kansas.

THERE has appeared from time to time in technical magazines and in newspapers the statement that an electric current passing through the surfaces of contact of a wheel and a rail upon which it ran, would increase the tractive power by increasing the friction between the wheel and the rail. It has even been stated that 30 per cent. increase of traction could thus be produced with a current of 30 ampères. The importance of this fact to electric railways is evident.

With a view of determining the general relations between the strength of a current and the coefficient of friction between metallic surfaces, a series of experiments was begun in September, 1889, in the physical laboratory of the State University. These experiments were carefully carried out by Mr. E. W. Caldwell, student in the electrical engineering course. The somewhat vague statements of the magazines were taken as authority for the fact of increased traction by the electric current.

The following four independent methods of experiment were devised:—

1. A column of mercury was made to flow between two platinum surfaces, each one inch square, each nearly parallel to the line of flow, and so arranged that a current could be sent, at will, from one platinum surface through the flowing mercury column to the other platinum surface. The accompanying illustration, fig. 1, shows the general arrangement of the experiments, in which A and B are the platinum plates.

The time of flow of a given amount of mercury, with and without current, would serve as a method of determining the effect of the current upon the coefficient of friction of mercury and platinum.

Two pounds of mercury were allowed to flow, and the time of flow without current was 29 seconds. A current of three volts, and varying from 0 to 1 ampère, was then sent from plate A to plate B through the mercury between them. No difference in time of flow was indicated. Mercury was selected, as no electrolytic action could take place at the surfaces of the platinum electrodes.

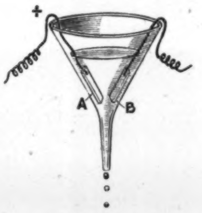

FIG. 1.

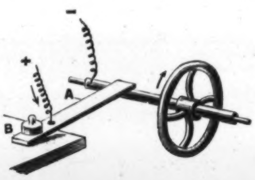

FIG. 2.

2. In the second method there was employed a steel spindle half-inch in diameter, with a small flywheel $2\frac{1}{2}$ inches in diameter rigidly attached to it. The arrangement is shown in fig. 2. A small steel bar, four inches long, rested near one end upon the spindle at A. The other end rested upon a smooth stationary surface. The spindle was made to revolve at a uniform rate of speed. The friction between spindle and bar tended to roll the bar over the spindle; but by applying suitable small weights upon the bar at the end, B, resting upon the smooth surface, the sliding friction at B was made to delicately balance the friction between bar and spindle at A, and the bar remained at rest upon the revolving spindle. A current of electricity was now sent through the contact of bar and spindle at A. No change in friction between bar and spindle could be detected.

3. A third method was as follows:—A metal bristle was soldered to the centre of the diaphragm of a Bell telephone, and projected a couple of inches out from its centre. The telephone was then so placed that the bristle rested across a rapidly revolving spindle, half inch in diameter. The friction of the bristle upon the spindle produced in the telephone a musical sound of definite pitch. A current of electricity was now sent through the contact between bristle and spindle. Had the friction been altered in any way the tone in the telephone would have been affected. No change in tone was produced.

4. Finally, for a fourth method, an experiment with sliding friction was tried. Two highly polished brass ways, A and B, fig. 3, about 4 feet long, were placed horizontal and parallel about three inches apart. A cross piece of brass, C, rested with its ends upon the strips. A cord attached to the centre of the cross-strip passed over a pulley and had suitable weights attached, just sufficient to so slightly overcome the friction of the strip upon the bars as to produce and maintain uniform motion of the strip to the ends of the bars. The surface of contact between strip and bars was made to vary in repetitions of the experiments from $1\frac{1}{2}$ to 3 square inches. A dynamo current of 10 ampères was now sent through the surfaces of contact by connecting

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* Paper read before the Kansas Academy of Science, Wichita, Kans.

one end of each bar to one dynamo terminal. The friction was unchanged. Uniform motion was still maintained without altering the weights.

It should be noticed that the currents employed were not sufficient to produce heating at the surfaces of contact. Such heating would doubtless produce an increase of the coefficient of friction.

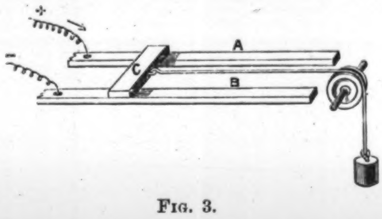

FIG. 3.

The four wholly independent methods described above would seem to justify the conclusion that the friction of rolling or sliding contacts is not affected by the electric current passing through the surfaces of contact, provided the currents are not strong enough to produce sensible heating effects.

Whether such heating effects occur between wheel and rail in electric railways, when transit is rapid, may well be called in question.

ON THE EXCITEMENT OF ELECTRICITY AND HEAT IN ELECTROLYTES.

By MAX PLANCK (*Annalen der Physik und Chemie*).

(*Concluded from page* 636.)

Section 10.—*Duration of the Process of Charging.*

In the foregoing applications we have always set out with the closely approximate assumption that the free electricities of the solution constantly place themselves for an instant in the equilibrium depending on the momentary concentrations, we will, in conclusion, view the phenomena of the process of charging (section 2), for the simple case that for $t = 0$, the concentrations in a solution of any given electrolytes given as functions of a co-ordinate, x, and at the same time the potential function, ϕ, being everywhere constant, so that in the first moment no free electricity at all is present in the solution. The equation (8) then holds good in the form :

$$-\frac{K}{4\pi c^2}\frac{\delta}{\delta t}\frac{\delta^2\phi}{\delta x^2} = \varepsilon\frac{\delta^2 U - V}{\delta x^2} + \frac{\varepsilon^2}{R}\frac{\delta}{\delta x}\left\{(U+V)\frac{\delta\phi}{\delta x}\right\},$$

or integrated according to x :

$$-\frac{K}{4\pi c^2}\frac{\delta}{\delta t}\frac{\delta\phi}{\delta x} = \varepsilon\frac{\delta(U-V)}{\delta x} + \frac{\varepsilon^2}{R}(U+V)\frac{\delta\phi}{\delta x} + f(t)$$

The time function, $f(t)$, is determined when $\delta\phi/\delta x$ is given at all times at a certain point. The entire duration of the process of charging is so short that in the mean time the concentrations, and therefore also U and V, cannot appreciably vary. If now we assume for the simplest case $f(t) = 0$, the equation can be integrated on the above suppositions after t, and we have :

$$-\frac{\delta\phi}{\delta x} = \frac{R}{\varepsilon}\cdot\frac{\frac{\delta(U-V)}{\delta x}}{U+V}\cdot\left(1 - e^{-\frac{4\pi c^2\,\varepsilon^2(U+V)t}{KR}}\right)$$

For $t = 0$ $\delta\phi/\delta x$ is everywhere $= 0$, according to the supposition. Hereupon the electric intensity begins very quickly to vary and arrives soon at its final value in accordance with equation (12). The rapidity of the process depends on the coefficient of t in the experimental function which, *e.g.*, for a normal solution H Cl ($U = u\,p = u\;.\;0{\cdot}001$ R and $V = v\;.\;0{\cdot}001$ and R) has the value :

$$4{\cdot}87\;.\;10^{10}\,[s^{-1}].$$

If this speed is consequently very considerable it does not exceed the limit demonstrable for the validity of Ohm's law.

WESTMINSTER ELECTRIC SUPPLY CORPORATION, LIMITED.

IN the areas of London, where a large demand for electric current is likely to be made, we imagine the above company occupies a favourable position. An Act of Parliament was obtained last autumn authorising the supply of electricity in Westminster, Mayfair, Belgravia, and Pimlico. To enable this to be carried out there will be erected three central stations. In the Mayfair district a station at Davies Street; Belgravia and Pimlico district will be supplied by a station at Eccleston Place; and Westminster will receive current from Millbank Street. When our representative visited the latter a few days ago he found the erection of the station in a most forward state. A certain amount of current is at present supplied from a temporary installation close by, which lights a considerable portion of the Houses of Parliament. A long length of underground main has been laid throughout the district, and steady progress continues to be made. We referred in a recent leaderette to the action of a company possessing equal powers in attempting to bind householders to take current, offering as an inducement that the electric light is almost ready. We see no signs of any lighting being done in this district for a long period except by the Westminster Company.

The system adopted by the company under review is the low tension feeder system. It is intended to keep each parallel of the network when it receives current from the feeders at a potential of 102, and the network of mains connecting the E.M.F. points is arranged so that the loss may not exceed two volts to any lamp. The network will be connected over the whole of the district. The system will be one worked on three wires with dynamos delivering at 220 volts, *i.e.*, dynamos delivering to the two outer wires, with the middle wire connected to batteries, which would act as regulators. The efficiency of the whole system is very little affected by the efficiency of the batteries, because only a very small portion of the whole current passes through the batteries; thus if the latter supply 10 per cent. of the whole current, and if their efficiency is only 80 per cent., although they lose 20 per cent., this loss only amounts to 2 per cent. on the whole current supplied. The whole battery power put through is therefore small, though it may be enough to supply all the current during hours of minimum demand, and by rapid discharge able to act for a short time in a breakdown, or in a sudden fog, whilst steam is being got up. An instance of this was given a short time ago during a sudden fog, the batteries being none the worse after working.

In the system of mains now being laid in the Westminster part of the corporation's district, the conductors are strained strips of naked copper on insulators in concrete culverts wherever there is room, and where there is no room insulated cables lying in wrought iron pipes. The system used in Mayfair and Belgravia will be so far similar as to include the use, where possible, of naked copper, while Callender's bitumen concrete conduits and Siemens's armoured cables will probably be employed in other places. Service boxes will be placed at such frequent intervals as will allow house connections to be made with a minimum of disturbance of the pavements.

EDINBURGH EXHIBITION.

EXHIBITS.

(*Continued from page* 574).

No. 10*a*. *Corporation of Birmingham.*—By special permission, the original Woolrich magneto-electric machine is exhibited here. It was patented in 1842, and used by Messrs. Prime and Son for many years in the deposition of metals at their works in Birmingham. This interesting relic was shown at the Birmingham Exhibition last year, and was illustrated on page 204, Vol. XXV., ELECTRICAL REVIEW.

No. 12. *Magnolia Metal Company.*—A number of samples of Magnolia anti-friction metal are shown, after having been tested in competition with other metals, or subjected to special trials, proving its superiority in the following respects—the non-heating quality of the metal; the fact that it will not cut journals; its great durability, and the saving in lubrication. It is said to be specially suitable for the bearings of dynamos and other high-speed machinery.

No. 20. *Prentice, Napier & Co.*—This firm shows some dynamos of novel construction, all wires being protected from injury by dirt or moisture by metal casings. The armature wires being wound between the iron projections on the armature core are driven mechanically in a very effective manner. The machines shown comprise a compound-wound dynamo, designed for an output of 15,000 watts at 800 revolutions; a compound-wound dynamo, designed for an output of 3,000 watts at 1,000 revolutions; a shunt-wound dynamo, designed for an output of 15,000 watts at 800 revolutions, and a shunt-wound dynamo, designed for an output of 3,000 watts at 1,000 revolutions, or for use as a motor.

There is also exhibited at this stall an engine of peculiar construction, made by Easton and Anderson, for driving a dynamo direct. It is a compound balanced high-speed engine, with cylinders 4 inches and 8 inches in diameter, with a 5-inch stroke and a speed of 550 revolutions per minute, and arranged to work compound with steam of 112 lbs. initial pressure. Its special feature is that it is provided with a charging valve to work both cylinders high pressure, with steam at, say, 50 lbs., this arrangement being particularly made for use on shipboard, so that engines may be worked either from the main or donkey boilers. When working high pressure, the steam to the large cylinder is partly throttled to equalise the powers of the cylinders to some extent. A plate of non-conducting material is placed between the piston rod end and crosshead to prevent heat travelling from the former to the latter as far as possible. The valves are of the ordinary slide type, driven by eccentrics, which form the webs of the crank. A centrifugal governor is attached to the end of the crankshaft, acting on a throttle valve, with a dashpot to control its motions. Means for lubrication of all parts are so arranged, that the engine may be run continuously. The dynamo driven by this engine will give an output of 11,000 watts at 550 revolutions.

No. 45. *Davis and Timmins.*—A very comprehensive collection of samples of machine screws, electrical terminals and fittings, cut from solid straight drawn metal by patent automatic machinery. This firm has adopted the standard dimensions for screws devised some time ago by a committee of the British Association. This standard was first adopted by the Postal Telegraph Department, but it is only recently that, in consequence of the recommendation of the Electrical Section of the London Chamber of Commerce, there has been any sign of its becoming popular among electrical manufacturers. It is generally admitted that the adoption of the standard would, by securing uniformity, be beneficial to the maker and user alike.

No. 47. *Woodhouse and Rawson United.*—At this stall is shown an automatic accumulator cut-out, the invention of J. W. S. Barber-Starkey, Esq., which is likely to have a large application in all installations where accumulators are employed. It is devised to automatically cut-in the charging circuit of accumulators as soon as the E.M.F. of the dynamo has reached a predetermined point, and to break the circuit again as soon as the E.M.F. has fallen to any desired point. Its action depends upon the movement of the armature of an electro-motor which is joined in shunt upon the terminals of the dynamo. The movement of this armature can be arranged to take place at any required E.M.F., first by the movement of a weight which acts against the electro-magnetic attraction; secondly, by the position of the armature with respect to the motor field when it is at rest. At the end of an arm joined to the armature on the opposite side of the weight are two prongs which, when the movement of the armature takes place, dip into two mercury cups, thereby completing the circuit from the dynamo to the accumulators. When no current is coming from the dynamo the weight causes these prongs to lie clear of the mercury cups. When the dynamo has reached a certain E.M.F. the attraction of the armature is sufficient to counterbalance the weight, and any slight movement causes it to move into a stronger field. The movement, therefore, which makes the circuit is a quick one. We will suppose that it is arranged to make circuit as soon as the E.M.F. has risen to 115 volts. The charging E.M.F. for, say, 52 cells will be considerably higher than this and the pull of the armature will be sufficient to keep the prongs depressed in the mercury against the action of a small spring acting at their end of the arm. If we suppose the E.M.F. to drop to, say, 106 volts the spring has sufficient force to raise the prongs slightly, the armature then being turned into a weaker field is enabled to overcome the force of the weight, and a quick movement of the prongs out of the mercury is ensured. By properly adjusting the position of the weight and the angle of the armature with regard to the magnet poles, when the circuit is broken, the instrument can be made to act over such a range as will cover all necessities for installations where accumulators have to be charged. The power absorbed by the instrument is infinitesimal, and by a proper proportion of the size of the prongs it can be used for any desired current, and in this respect appears superior to any solenoidal form of instrument devised to do the same work. The great difficulty hitherto experienced in securing a sufficiently quick break appears to have been successfully overcome. The instrument has been put into the hands of Messrs. Woodhouse and Rawson United, Limited, who will no doubt secure for it the popularity which it certainly deserves.

At the same stand is shown Scott's electric flash signalling lantern, for signalling by flashes according to the Morse alphabet. A recording instrument is used in combination with this, whereby all messages are recorded for future reference. An ingenious key of special construction is used in combination with the above, so that the incandescent lamp is only running during the time of actual signalling. Another exhibit here is Horn's electric tachometer for indicating directly the speed of a rotating shaft. The action of this is founded upon Arago's discovery of the currents set up in a copper disc when rotating in a magnetic field. The disposition of the instrument is such that its calibration is not affected by a variation in the strength of the permanent magnet employed, while its sensitiveness is superior to any form of centrifugal speed indicator. It is specially useful for marine and railway purposes, where it is subject to shocks which have practically no effect upon it. Its sensitiveness enables it to be specially useful in detecting slipping belts, which are a fertile source of loss of power in mills, &c.

Messrs. Woodhouse and Rawson also show several specimens of a new insulating material, suitable for the bases of switches and other work requiring high insulating properties, coupled with uninflammability. This new substance can be moulded accurately to any desired form, and metal parts can be firmly embedded in it during the process of moulding. As the main constituent employed is Portland cement, it naturally is not of so expensive a nature as any of the substitutes for slate. It is waterproof, and possesses enormously high insulating properties. Included in this company's general exhibit are a large variety of instruments, such as voltmeters, ammeters, rheostats, arc lamps, miners' portable lamps, wire testing apparatus, and railway telegraph instruments, in addition to which there is a show of bells of every possible size, probably the most complete yet made, one large bell being utilised by the exhibition authorities for automatically striking the hours, and tolling continuously for some minutes at the hour of closing.

Naturally a large amount of space is devoted to switches and cut-outs, which form the principal specialities of the company, and of which they claim to be the largest manufacturers in the world. We have already given a short description and illustrations of several of their leading types in these columns, but would draw the special attention of our readers to the new type diamond switches for large currents, several of which are shown on the stand. The workmanship and finish throughout are of first class quality, all parts being carefully made to standard gauges, and every instrument being thoroughly tested before it leaves the works.

The principal types made by the company are the B.W., which is a small single light switch for use with brackets and electroliers; the G. and "Diamond" quick-break switches for single lamps and groups, and the F. and I. switches for accumulators, &c. The Cunningham and Woodhouse and Rawson magnetic cut-out is also on view, and we understand that the sale of this well-known instrument is even larger than before, the many years it has been on the market having only added more convincing proof of the excellence of the design.

No. 68. *The Electric Construction Corporation.*—The exhibits, as shown by this corporation, comprise a great variety of plant for all purposes, including lighting, both on the alternating and direct systems, which are demonstrated in the latter case by the storage system and continuous current dynamos; all kinds of plant for isolated installations for business places, private or public buildings; also plant for transmission of power, propulsion of tramcars, lifts, launches, &c., and consist of the following:—An electric tramcar capable of seating 40 passengers. This is the latest and most improved type of the self-contained electric tramcar, and is fitted with storage batteries and propulsion gear consisting of electric motors and gear to couple same to axles, and switch for starting and stopping, and for regulating the speed of the car. The tramcar is suitable for running on any line of suitable gauge without any preparation or alteration of the permanent way. A 50-light storage battery, consisting of 55 E.P.S. 1888 type, L 15 cells, in glass boxes, erected complete and in working order on trays, insulators, and with glass covers, as they would be in any installation. These are capable of maintaining 50 16-C.P. lamps for nine hours after being fully charged. King's E.P.S. automatic distributing gear, as used since April, 1889, by the Chelsea Electricity Supply Company, Limited, in whose district in London the supply is solely maintained from storage batteries. This gear regulates automatically that the batteries in each storage station should be charged one-half at a time, in series, and is arranged to automatically change over to the second half when the first half has been fully charged. When both halves have been fully charged they are put in parallel on to the lamp circuit, and are arranged to be so connected at the time of the maximum output for he evening. 100-kilowatt combined alternating dynamo and engine, complete and in working order, and capable of developing 100 ampères at 1,000 volts, or 3,330 lamps of 30 watts. Sixteen of these plants are being now supplied and erected for the Metropolitan Electric Supply Company, Limited. This dynamo is shown running the lights fixed round the stand, and also those forming the name of the corporation, by means of 12 Parker transformers, which transform the E.M.F. of 1,000 volts down to that of 100 volts, and are each capable of working 200 lamps of 30 watts each.

Sprague car equipment.—This is a type of the single motor equipment on the "Sprague system." It will be noted that the gear is carried by the axle, and the other end is supported by springs from the car body. A perfectly steady suspension is thus obtained, and vibration and jolting of the wheel base running on the track does not affect the motor and its gearing. This system, with further accessories, making it very complete and distinct by itself, has been very largely adopted in all sizes of cars, in single and double types, in the United States, and is giving entire satisfaction.

Two continuous current dynamos erected in working order on slide or belt tightening rails, one driven from the shaft of the alternator, and one driven from a separate engine; each machine is capable, at one and the same time, of exciting the field magnets of the alternator, charging the storage battery, and running two motors on neighbouring stands (Messrs. The Singer Manufacturing Company), and of lighting 120 16-C.P. lamps.

Various types of accumulator batteries, as used for central station work or in large private installations, for ship lighting and other similar purposes, for train lighting, and for traction and propulsion purposes. A special cell in ebonite box, and shaped to take advantage of the slope of the boat, is fitted with 15 E type plates, and is capable of discharging at 35 to 40 ampères. The cells are identical with those used in the launches running on the exhibition canal. Another ebonite cell shown is the same type as those used by the Electric Traction Company, Limited, on the Barking line, for propelling the cars of the North Metropolitan Tramways Company and elsewhere, and each compartment contains 19 E-type plates, and is capable of discharging at 35 to 40 ampères. Three types of portable batteries, intended for lighting individual lamps for carriages, or for reading lamps, medical work, &c. One has four cells, each with three T-type plates, and another one has eight cells with the same number and type of plates; the third one has four cells, each with three plates of the C type.

Two types of distribution switchboards for use in installations where accumulators are used. The larger is suitable for an 80 ampère circuit of 100 volts, or more, and is fitted with patent ring contact switches. The smaller is suitable for a 60 ampère circuit of less than 100 volts, and is fitted with neat "tongue" type switches. These switchboards are provided with regulating switches, both for the charge and discharge, so that the dynamo can be charging the full or any less suitable number of cells, while the lamps on the circuit are being worked at their proper voltage, and thus over or under incandescing is avoided.

Accessory instruments, for installations in which accumulators are used, are shown in the shape of an automatic current alarm, which is used for giving warning, by the ringing of a bell, when the current that is being taken from or given to the cells in the form of discharge and charge respectively, is at too high a rate. A low constant voltmeter for testing the E.M.F. of the cells. This is a handy instrument that enables the rapid testing of a battery of cells, and when used during maximum discharge gives a very correct reading, and enables the exact condition of charge of the cells to be ascertained. Automatic "make and break" switch for use with accumulators. This instrument is placed in the main circuit, and when the E.M.F. of the dynamo is sufficiently high to overcome the counter E.M.F. of the cells, it completes the main circuit and breaks the main current to the cells when the current from the dynamo, from any cause falls to zero. These apparatus are very useful in installations where the attendant has other duties, beside attention to the electric plant, to attend to, and has to leave the dynamo running. Different types of quick break "on and off" switches with and without fuse plug. Direct reading ammeters and voltmeters, which are shown in connection with the switchboards. Two different sizes of Parker transformers, as used at Newcastle, London, Melbourne, &c. Switchboard complete, used with the alternating circuit from the alternator in work. This is fitted with long break plug switches, alternating current ammeter, voltmeter showing the E.M.F. of a known portion of the primary circuit; also a switch, an ammeter, and variable resistance for the exciting circuit.

No. 87. *Faraday and Son.*—This exhibit consists of a stall draped in folds of cloth, with arcaded recesses at the back. The articles displayed are chiefly artistic novelties in fittings for electric light. These are more especially adapted for house lighting, and particularly for reception rooms of a good class, such as electroliers of an airy lightness, with clustered lamps and hammered foliage, coronæ and hand-made scroll work in filigree and other artistic treatment. The prominent articles include a new shrine lamp in pierced and repoussé metal, resembling the delicate Venetian work of the 17th century; bronze and silver figures from models of the Renaissance, bearing electric torches or cressets, and standards or tripods, adaptable equally as wall fittings or brackets, with a patent gimbal arrangement of the top shade. Also brackets with swivel arms, and others in the plain Dutch or rich Louis XIV. styles. The firm show also an adjustable reflecting pendant, "the perfect," for desk use, patented by Sir David Salomons, and a "universal" wall plug by the same inventor, which is intended not only for flexible corded wires, but for interchangeable brackets and pendants. Many of these novelties are shown for the first time, and are lighted after dark.

LIGHTNING CONDUCTORS.

By S. ALFRED VARLEY.

SECOND SERIES.

(*Continued from page* 636.)

Electric Alternations.

WHEN rapid alternations are being transmitted a succession of ring waves of magnetism (suggestive of the waves formed when a pebble is thrown into a lake) are produced in the conducting wire, these ring waves change their magnetic direction at each alternation, and before the magnetic polarity produced by, say, a + alternation can be reversed the ring wave must fall to zero, and during such fall the energy transformed and stored in the conductor in producing the wave is parted with, developing current in the same direction as the + alternation.

Now, when electric alternations are transmitted in rapid succession the currents developed during the successive acts of demagnetisation must represent a considerable percentage of the energy transmitted, and the currents so produced are necessarily developed throughout the whole mass of the conductor, and also at a higher potential in the central portion than in the outer skin, that this is necessarily so, seems so self-evident to the writer that he does not consider it necessary to occupy space by giving reasons.

An electric impulse immediately following one in the opposite direction would at first sight appear to more rapidly demagnetise the conductor and to raise the potential of the "extra current" developed by shortening its duration; the writer is, however, of opinion that the effect of a sudden reversal is simply to bring about a temporary check to the transmission of energy, and it is only right that he should say he has been assisted to such conclusion by certain facts recorded in the Dr. Mann lectures, and described by Prof. Oliver Lodge under the heading—"The Experiment of the Alternative Path."

Rapid alternations endeavour to set up electric motion in the conductor in opposite directions at one and the same time, and so produce eddies. All those who have had practical experience with hot water systems, or the circulation of air, are well aware of the great check to transmission eddy currents are capable of producing.

When energy is being transmitted by electric alternations the resistance opposed in the circuit, between each alternation, must necessarily approach the infinitely great, during an infinitely short interval of time, and at these dead points something must give way. The revolving armature itself possesses a certain amount of inertia, and this, combined with the energy stored in the flywheel, overcomes any temporary resistance; in addition to this there is a reserve of energy in the boiler, which comes into action automatically, and within certain defined limits maintains the rate of motion.

What happens at the periods of greatest resistance is the development of eddy currents to a greater or less degree in the dynamo (chiefly in the revolving armature), and the effect is also to accumulate electricity statically on the surface of the conducting wire, similarly as happens in submarine circuits, but the surface exposed by electric light systems is very small compared with that of submarine cables; and, therefore, the conditions are not nearly so favourable for statical accumulations to occur, but, on the other hand, the potential of the electrical alternations of an electric light system is some hundreds of times greater than that of the alternations employed in telegraphy, and statical accumulations of electricity to a certain extent do undoubtedly occur, and in some degree relieve the strain in the dynamo.

Now, if the iron cores of the armatures of an alternating dynamo be both laminated and also well insulated, and if the insulation of the convolutions be very perfect, then, as is well known, the production of eddy currents is very much lessened; and what follows, under such conditions, is that instead of eddy currents being developed, the magnetic inertia of the iron is overcome to a larger degree, and at the periods of very great resistance in the circuit the production of current *almost entirely* ceases, the magnetic polarity of the iron becoming raised by the *transformation* of *energy* into *magnetism* and temporarily stored, *instead* of electricity being developed—so soon as the dead point has been passed and the resistance in the circuit begins to decrease, the energy stored in the dynamo in the form of magnetism becomes parted with, helping to develop current.

The above views, which have been enunciated in previous articles and are in a sense peculiarly the writer's own, will probably not find ready acceptance at the hands of certain of our physicists, but the writer himself is strongly convinced of their truth, and he anticipates the time will come when their general correctness will *have* to be admitted by mathematicians.

If a mass of matter be dropped from a height, gravity causes it to fall towards the centre of the earth at a speed which progresses in accordance with a regular law, such speed being the complement of the energy imparted to the mass by gravity, and the energy so imparted is directly as the weight of the falling body multiplied by the time gravity has been acting upon it.

Assume the falling body to be a mass of iron surrounded by a closed copper circuit, and interpose in its path just before it reaches the ground a magnetic field; the falling mass will pass into the magnetic field with the accumulated energy due to the action of gravity, and on entering the field it encounters magnetic inertia—in other words, the mass of iron surrounded by copper enters into a magnetic system, and there becomes subjected to the influence of magnetic gravity, a force resembling in no small degree terrestrial gravity.

If a mass of falling matter be acted upon by a second force, and as a consequence the rate of motion becomes increased beyond that produced by gravity, this second force will have to overcome inertia proportionate to such acceleration of the rate of motion, and this involves what is very commonly but somewhat incorrectly termed an expenditure of energy, for energy being indestructible all that can happen to it is a change of shape; and in the example given what occurs is simply a transformation of energy into heat motion, set up in the mass whose speed has been accelerated.

What occurs when a mass of iron surrounded by copper which has been set into motion by the action of gravity passes into a magnetic field is not unlike that which has been referred to above, as taking place when matter under the influence of gravity solely, becomes acted upon by a second force. The energy which gravity has imparted to the mass of iron and copper encounters the inertia of the magnetic field, and also the magnetic inertia and self-induction both of the iron and also of its copper envelope, and what follows is a transformation of energy equivalent to the resistance encountered and overcome into electric current; but as the magnetic inertia and self-induction of copper is many hundreds of times less than that of iron, it is the magnetic inertia of the copper which is chiefly overcome, and the current is almost wholly developed in the copper circuit *instead* of overcoming magnetic inertia and developing magnetism in the mass of iron. Now if for the sake of argument it be assumed that the copper circuit surrounding the iron has neither magnetic inertia nor self-induction, and that it opposes no conductive resistance, then no magnetism whatever would be developed in the iron during its passage through the magnetic field, providing that the speed at which the mass of iron and copper was travelling approached the infinitely great, but as all conductors oppose magnetic inertia and conductive resistance, and as there is also *considerable* self-induction in all closed helical circuits, there is necessarily a percentage of energy transformed into magnetism whenever a mass of iron surrounded by a copper circuit passes through a magnetic field; but in the revolving armature of a dynamo, which is a case in point, the energy which does become transformed into magnetism is given out at each succeeding change in the direction of magnetic polarity as current, and there is, therefore, theoretically, no waste.

Prof. Lodge's "Alternative Path Experiments."

As we may be very sure there are no real anomalies in physics, whenever carefully conducted experiments give results apparently not reconcilable, the chances are that the experimenter has broken fresh ground, a further investigation of which, by leading to discovery, will in all probability demonstrate that what appeared at first sight so puzzling, is, after all, only what more complete knowledge would have anticipated. It was with some such feelings as the above that the "alternative path" experiments were regarded at the time of their publication; the results obtained stood out apart from all theory, but the interpretation of the experiments by their own author did not seem satisfactory, and the writer felt this so strongly at the time that he ventured to express the opinion, through the columns of this journal, that "he suspected what had been observed was attributable to causes other than those which seem to have satisfied Prof. Lodge." As, apart from their scientific interest, the alternative path experiments have a very direct bearing in connection with lightning conductors, the writer refers to them again; but the excuse he pleads for doing so is that he thinks he is able *now* to give the true explanation of what was observed by Prof. Lodge.

When two Leyden jars (fig. 23), having their outer coatings connected with the metal wire, L, were charged oppositely until discharge took place between the balls, A, Prof. Lodge found that if the two balls, B, were approached to within a certain distance from one another (termed the critical distance) that, notwithstanding there was a metallic connection between the outer coatings of the two jars, a spark passed across the air space, B, at the same time as at A. It was further observed that the Leyden jar discharge was sharper and louder when the balls, B, were within the critical distance than when they were separated by too great an air space for the B spark to be produced.

A sharper and louder noise indicates, undoubtedly, a more rapid completion of the Leyden jar discharge; and it is desired to direct attention *specially* to the fact that the act of discharge was evidently completed in less time when the balls, B, were within the critical distance, and so permitted the B spark to be produced. The fact that the discharge was more rapid when the balls, B, were within the critical distance, apart from its bearing on lightning conductors, helps, as will be shown further on, to a clearer understanding of what takes place in an electric circuit when transient currents or when rapid alternations are being transmitted, and the observation that the act of discharge becomes completed in a shorter interval of time under such conditions is of considerable scientific interest.

The conclusion that Prof. Lodge arrived at was that the discharge between the oppositely-charged outer coatings of the two Leyden jars occurred through the air space at B, *instead of through the metal conductor*, L.*

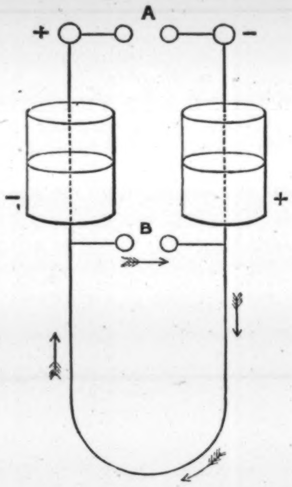

FIG. 23.

In the course of his experiments Prof. Lodge employed copper and also iron wires of approximately equal length, but of varying section, for the path L, and he also employed acid and water in a capillary tube, which opposed a conductive resistance = 300,000 ohms for the path L.

The results obtained are given in the annexed extract from the published report of the Dr. Mann lectures:

Alternative Path.		Critical B spark-length.
Stout copper wire, No. 1	R = ·025 ohm	... 14·3
Ordinary copper wire, No. 19	R = 2·72 ,,	... 13·4
Stout iron wire, No. 1	R = ·086 ,,	... 10·8
Ordinary iron wire, No. 18	R = 3·55 ,,	... 10·8
Thinnest iron wire, No. 27	R = 33·3 ,,	... 10·3
Capillary tube	R = 300,000 ,,	... 16 to 17.

The points to which it is desired to direct attention to are—

1. That the act of discharge occupied less time when the balls, B, were within the critical distance, and a spark passed across the air space, B.

2. The larger the section of the copper wire employed for the path L, *the greater the length* of air space which was capable of being bridged by the spark at B.

3. That there was a specific difference between iron and copper in their behaviour when employed for the path, L, which was irrespective of their respective sections.

4. That when the path, L, was formed of a fluid conductor of great resistance, the discharge was *very* quiet, indicating that the act of discharge was of longer duration; but nevertheless the air space at B leapt was

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* Mr. Wimshurst has demonstrated that the spark which passes at the air space, B, is in the same direction as the discharge through L, and therefore it is not an alternative one.

considerably greater than it was with the copper wire of largest sections employed.

Prof. Lodge and other mathematical physicists will, of course, admit that the spark produced at B arises out of inertia resistance in the metallic path, but whilst admitting that the spark at B is an inertia phenomenon, it must also be admitted that the results recorded by Prof. Lodge may be taken as demonstrating :

1. That copper conductors of large section are more effective for bringing about rapid discharge, and therefore it is a fair inference that lightning conductors of solid copper wire of large section, conduct lightning discharges *more quickly* to the earth than solid conductors *of smaller* section, and that consequently lightning conductors made of copper, of large section, would be more efficient than conductors made of copper *of smaller* section.

2. That seeing the spark produced at B is a consequence of inertia resistance, the fact that this spark was greater when the section of the conductor was increased, conclusively demonstrates that increasing the section exalts inertia phenomena, and seeing that inertia phenomena are exalted when conductors of larger section form the path of discharge, it is *clearly* evident that the discharge passes *through the mass*, for inasmuch as the outer surface of a conductor of large section is greater than that of a conductor of smaller section if the discharge were confined to the outer skin, it would penetrate to less depth in conductors of larger diameter, and the spark at B should be less instead of becoming greater, when the section is increased.

3. The fact that the noise made by the act of discharge is sharper and louder when the balls, B, are within the critical distance, and a spark at B is consequently produced, indicates that less time was occupied in discharging the Leyden jars, and that therefore the sum total of resistance opposed to rapid discharge, from whatever cause it may arise, *must* be less when the conditions are such, that a spark is produced at B, and that this is evidently so, is a very interesting scientific fact, which somehow seems to have escaped Prof. Lodge's attention.

4. The fact that the noise was less at the time of discharge, when the L path was a copper wire of small section, notwithstanding the balls, B, were within the critical distance, goes to show that the discharge passed through the copper wire, otherwise it would have had no effect on the sound produced, and further, as the critical distance was less with wires of smaller section than with the heaver copper conductors, the inertia phenomena were evidently less, and this also points to the fact that the discharge must have passed through a smaller mass of matter.

Prof. Lodge's recorded results, which have been here reproduced, it must be admitted, go to show that if the function of a lightning conductor is *to conduct*, and *not to obstruct and delay* the passage of lightning, that copper is a very superior material to iron for lightning conductors, chiefly on account of its relatively low specific magnetic inertia, but also on account of its much higher conductivity.

Mr. Wimshurst made the important observation that the spark observed at B was not, as Prof. Lodge regarded it, an alternative one, and he has demonstrated that it passes in the direction indicated by the arrow (fig. 23) ; this observation of Mr. Wimshurst's has afforded a clue to tracing the B spark to what is believed to be its real source.

At the time the Leyden jars are discharging a + discharge passes from the outer coating of the right hand jar in the direction indicated by the arrows through the conductor, L, to the outer coating of the left hand jar, magnetic inertia is opposed by the metal path, L, and this inertia is overcome by energy accumulated in the statical charge, which becomes transformed into magnetism, and in such form is stored in the metal path, L ; the flow of electricity commences as a small current because of the inertia encountered, and it rises as inertia is overcome, until the maximum flow is reached. Immediately after this the current begins to fall ; the magnetism developed in the conducting path, L, represents the inertia overcome, and it therefore necessarily reaches its maximum potential at the same moment as the current arrives at its maximum. The magnetic potential also commences to fall so soon as the current does, it therefore follows that demagnetisation is occurring *at the same time* as the discharge of the Leyden jars is proceeding, stored energy being parted with in the form of current, tending to facilitate the completion of the Leyden jar discharge.

The current arising out of the demagnetisation of the conductor, L, has its source undoubtedly in energy accumulated in the Leyden jars, but nevertheless it is produced in the path, L, itself, being distinct from the electricity of the Leyden jars themselves, and it may be regarded as *additional* to the discharge proper. For *the rapid development* of this current, *a complete circuit* is demanded, and if the air space, B, is short enough to be electrically bridged a complete circuit is established, less resistance is opposed to rapid demagnetisation occurring, and the dissipation of energy can proceed more rapidly. Now, if the air space at B is too large to be bridged across, when demagnetisation commences, the energy which was transformed into magnetism in the act of overcoming inertia, becomes dissipated by setting up eddy currents in the path, L, demagnetisation is consequently impeded, and a longer time is required to complete the discharge. The Leyden jar discharge through the path, L, may be divided into two halves—there is first the interval of time which is absorbed by the discharge in rising from zero to the maximum flow, and the time taken in falling from the maximum flow down to zero, the time occupied by a statical charge in falling from the maximum flow to zero depends largely on the conditions prevailing, and under certain conditions it takes a very *much* longer time to fall than it did to rise to its maximum. Now, it will be seen on reflection, that whether the balls, B, are within the critical distance or not, can make no manner of difference to the rate at which the inertia opposed by L is overcome, but so soon as the maximum flow has been reached, and the electrical and the magnetic potentials begin to drop, the fact that the balls, B, are within the critical distance, will have great influence on the rate at which the flow falls to zero. It will further be seen that when rapid alternations are being transmitted through a circuit that the conditions are exacerbated, which tend to retard demagnetisation, for the complete circuit which is requisite for rapid demagnetisation to occur, becomes in effect divided, as a consequence of the sudden change of direction of electrical motion.

There are two facts of considerable interest which stand out clearly in the "alternative path" experiments—viz., that increasing the section of solid cylindrical conductors increases the inertia phenomena, demonstrating that more inertia has to be overcome when the section of a conductor is increased—this, in the language of *common* parlance, involves an expenditure of energy directly as the inertia encountered, and yet, notwithstanding the greater amount of inertia which is undoubtedly encountered and *has* to be overcome, the recorded results of Prof. Lodge demonstrate plainly that a Leyden jar discharge is completed in less time through a solid cylindric conductor of large section, than through conductors of smaller section.

What has been stated immediately above, may at first sight appear to be somewhat anomalous, but the writer hopes to be able to make it plain that there is no real anomaly after all.

What was observed and recorded by Prof. Lodge in connection with his "alternative path," experiments it is thought, can be simply explained with the aid of the working theory developed in the course of this article. According to the writer's theory, all physical phenomena have their basis in *energy* and *inertia*, and, secondly, that all things are linked together by a process of continuity, no hard and fast lines dividing one thing from another, which the mathematical method of investigation practically assumes to be the case.

Inertia is the most distinctive feature of matter, and the overcoming it, has been described by the writer as imparting energy to matter, the matter acted upon by energy, unwillingly acquiring a new property or force for which it has no affinity. As matter resists energy being imparted to it, work has to be performed proportionate to the resistance encountered; but what is called work is simply a transformation, and not an expenditure of energy, the energy transformed existing in some shape or other in the matter to which it has been transferred, and this imparted energy can be parted with, only, when the conditions are such as enable it to pass into some other receptacle.

In the case of an electric conductor, such, for example, as the path, L (fig. 23), overcoming the inertia of the conductor, means a transformation of energy into magnetism, in which shape it becomes *stored* in L, and when the conditions enable the conductor to part with it, the energy stored as magnetism is capable of overcoming resistance equivalent to that which the conductor opposed at the time of its reception.

What follows when the section of the path, L (fig. 23), is increased, is simply a larger transformation of energy into magnetism, and consequently the flow of electricity, when discharge commences, takes a longer time to rise from zero to the maximum current; but the moment the maximum has been passed, the stored energy is set free, and increases the rapidity with which the discharge falls down to zero, and the rapidity with this is effected is further increased if the balls, B, are within the critical distance, so that a complete circuit can be formed through the medium of the B spark*.

It will be seen, from what has been stated, that when the section of the path, L, is a large one, the increased time absorbed by the Leyden jar discharge in rising to its maximum flow, is balanced by the rapidity with which it falls to zero after the maximum has been reached, and the superior conductivity of metal paths of large section, over that of conductors of smaller section, assists the rapid completion of the act of discharge.

After what has been already stated, it will be seen that the specific difference observed between copper and iron paths admits of easy explanation. Iron opposes about six times the conductive resistance of copper, but, at the same time, it possesses an enormously greater capacity for the storage of energy in the shape of magnetism than is possessed by copper. Owing to this greater capacity, and the existence of something akin to affinity between magnetism and iron, and although iron opposes much more inertia than copper, an iron path parts with magnetism much more slowly than a copper one, and consequently the potential of the current developed at the time demagnetisation is occurring is not so great. Copper not only demagnetises more quickly than iron, but it demagnetises also more completely, and the current produced by the demagnetisation is conducted six times as freely; whereas iron, on the other hand, parts with magnetism comparatively slowly, retains more or less of it permanently, and conducts current very much less rapidly.

In the experiment where the path, L, was acid and water contained in a capillary glass tube, and which opposed a resistance of 300,000 ohms, the Leyden jar discharge was observed to be very quiet indeed, indicating a slow rate of discharge, yet the spark at B passed across a greater amount of air space than when the L path was a copper one of large section and low resistance. The greater the section of a copper, L, path, the greater the critical length between the balls, B, as recorded by Prof. Lodge; but the writer almost ventures to assert that if the L path when acid and water is employed were increased in section, the critical length of the spark at B would be found to be reduced; and, further, he is disposed to believe the spark observed at B, when the capillary tube containing acid and water formed the L path, occurred in the opposite direction to that developed when metal wires were employed.

(*To be concluded.*)

THE LOSSES DUE TO HYSTERESIS IN TRANSFORMERS.

THE following interesting discussion has appeared recently in the columns of the New York *Electrical Engineer*:—

In your issue of April 2nd, in referring to certain remarks made by me at the recent meeting of the American Institute of Electrical Engineers on the subject of hysteresis you make the statement: "It is this constancy of relation that, as Mr. Tesla pointed out . . . . may ultimately establish the correctness of the hypothesis advanced, that in reality there is no loss due to hysteresis, and that the changes of magnetisation represent a charging and discharging of molecular energy without entailing an actual expenditure of energy."

I do not recollect having made such a statement, and as I was evidently misunderstood, you will greatly oblige me by inserting the following few lines, which express the idea I meant to advance:—

Up to the present no satisfactory explanation of the causes of hysteresis has been given. In the most exhaustive and competent treatise on the theory of transformers, by Fleming, static hysteresis is explained by supposing that "the magnetic molecules or molecular magnets, the arrangement of which constitutes magnetisation, move stiffly, and the dissipation of energy is the work done in making the necessary magnetic displacement against a sort of magnetic friction." Commonly it is stated that this is a distinct element in the loss of energy in an iron core undergoing magnetic changes entirely independent of any currents generated therein.

Now it is difficult to reconcile these views with our present notions on the constitution of matter generally. The molecules of iron cannot be connected together by anything but elastic forces, since they are separated by an intervening elastic medium through which the forces act; and this being the case is it not reasonable to assume that if a given amount of energy is taken up to bring the molecules out of their original position an equivalent amount of energy should be restored by the molecules reassuming their original positions, as we know is the case in all molecular displacements? We cannot imagine that an appreciable amount of energy should be wasted by the elastically connected molecules swinging back and forth from their original positions, which they must constantly tend to assume, at least within the limit of elasticity, which in all probability is rarely surpassed. The losses cannot be attributed to mere displacement, as this would necessitate the supposition that the molecules are connected rigidly, which is quite unthinkable.

A current cannot act upon the particles unless it acts upon currents in the same, either previously existing or set up by it, and since the particles are held together by elastic forces, the losses must be ascribed wholly to the current generated. The remarkable discovery of Ewing that the magnetisation is greater on the descent than on the ascent for the same values of the magnetising force strongly points to the fact that hysteresis is intimately connected with the generation of currents either in the molecules individually or in groups of them through the space intervening. The fact observed accords perfectly with our experience on current induction, for we know that on the descent any current set up must be of the same direction with the inducing current, and, therefore, must join with the same in producing a common effect; whereas, on the ascent, the contrary is the case.

Dr. Duncan stated that the ratio of increase of primary and secondary current is constant. This statement is, perhaps, not sufficiently expressive, for not only is the ratio constant, but, obviously, the differential effect of primary and scondary is constant. Now any current generated—molecular or Foucault currents in the mass—must be in amount proportionate to the difference of the inductive effect of the primary and the secondary, since both currents add algebraically—the ratio of windings duly considered—and as this difference is constant, the loss, if wholly accounted for in this manner, must also be constant. Obviously I mean here the transformers under consideration, that is, those with a closed magnetic circuit, and I venture to say that the above will be more pronounced when the primary and secondary are wound one on top of the other, than when they are wound side by side; and generally it will be the more pronounced the closer their inductive relation.

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* The spark which occurs at B is produced by the demagnetisation of the path, L, and as the magnetism developed in the path represents inertia overcome, and as the larger the section the greater the inertia encountered, the spark at B is also greater when the section of the copper path is increased.

Dr. Duncan's figures also show that the loss is proportionate to the square of the electromotive force. Again, this ought to be so, for an increased electromotive force causes a proportionately increased current, which, in accordance with the above statements, must entail a loss in the proportion of the square.

Certainly, to account for all the phenomena of hysteresis, effects of mechanical vibration, the behaviour of steel and nickel alloy, &c., a number of suppositions must be made; but can it not be assumed that, for instance, in the case of steel and nickel alloys, the dissipation of energy is modified by the modified resistance; and to explain the apparent inconsistency of this view, we only need to remember that the resistance of a body as a whole is not a measure of the degree of conductivity of the particles of which it is composed.

N. TESLA.

In his letter appearing in your issue of April 9th, Mr. N. Tesla in discussing the losses due to hysteresis in transformers takes the ground that such losses outside of the generation of electrical currents, or independent thereof, are "difficult to reconcile with our present notions on the constitution of matter generally." Further on he says: "We cannot imagine that an appreciable amount of energy should be *wasted* by the elastically connected molecules swinging back and forth from their original position," &c. While I agree with Mr. Tesla that the actual loss referred to may be due to molecular currents, yet we have no proof of such fact. Again Mr. Tesla seems to forget that *loss*, *waste*, and such terms, are more scientifically rendered, by the words "*conversion into heat*," and that in nature nothing is wasted or lost, but merely converted.

Now we may consistently amend his quoted statement as follows, and see how it reads: "We cannot imagine that an appreciable amount of energy should be converted into heat by the elastically connected molecules swinging back and forth from their original positions," &c.

Heat action is that swinging back and forth referred to, namely, "molecular vibration," and if we find that such swinging takes place we must have heat as a result. When the molecules can polarise or turn without being given a swinging movement or vibration, no conversion into heat takes place. The difference then between very soft iron and hard steel so far as magnetic waste goes, is, apparently, that in the soft iron there is less disturbance of position of the molecules during magnetisation and reversal than in steel, assuming the degree of magnetisation or polarisation to be equal in each. The *waste* or conversion due to electrical resistance is of the same nature. Whenever the ether strain can be transmitted from molecule to molecule of the conductor without much disturbance of their positions or without causing a swinging out of position back and forth, the conductivity is great, and the reverse is true with bad conductors.

In like manner, bending a bar of tempered steel back and forth within limits is mechanically efficient, because very little conversion of motion into heat takes place, and this is a result of the relative positions of the molecules being preserved; while, bending a bar of inelastic metal, as a copper rod of moderate hardness, produces heat by disturbance and swinging of molecules. Such bending is inefficient.

There is then to my mind no more difficulty in understanding that a conversation into heat may be produced magnetically than electrically, or mechanically. Indeed, if, as seems probable, these actions are but variations of ether strain phenomena they are reducible to a single effect, and represent the molecular disturbances produced by transmission of ether strains. Cohesion, gravitation, and forces acting between molecules, must of course be recognised as results of ether strains.

Molecules themselves, or matter itself, may be resolvable into ether movements or vortices, and we may be able to put "energy indestructible" in place of "matter indestructible" and mean as much. We need to forget the universe as made up of pieces, entities, or particles, put together and allowed to interact and react, and learn to regard it as a consistent whole from which nothing can be taken without disturbing the balance or equilibrium of what remains. It is in my view more legitimate to attribute the heating effects of Foucault currents and other currents to a general molecular friction or hysteresis of conduction, if we may use such a term, than to assume the production of molecular currents in the heating or conversion of magnetic hysteresis. We have no present need of currents in accounting for heat conversion of mechanical friction and molecular friction of inelastic bodies when bent or distorted by mechanical force. Neither can we deny that theoretically such conversion into heat may be accompanied by molecular electric currents similar to eddy currents or Foucault currents, but infinitely more restricted as to length of circuit. On these points and others of equal interest we may speculate, but are in need of more facts to confirm our speculations.

ELIHU THOMSON.

Lynn, Mass.

In your issue of April 9th, in elucidation of certain remarks made by me at one of the meetings of the American Institute of Electrical Engineers, I have made some statements on hysteresis, which Prof. Thomson has commented on in connection with his own views on the same subject, as expressed in your issue of April 30th.

Prof. Thomson makes a quotation from my letter which shows that he has not properly understood some of my statements, and then goes on to say: "Mr. Tesla seems to forget that *loss*, *waste*, and such terms are more scientifically rendered by the words 'conversion into heat,'" . . . and, "Now we may consistently amend this quoted statement, &c."

My statements were the outcome and, as it were, a continuation of a practical discussion, and I attached to the words used no philosophical meaning. By energy "wasted" I meant what probably everybody else except Prof. Thomson understood me to mean, namely, energy supplied to the core and not available for a useful purpose. Prof. Thomson states further: "Mr. Tesla seems to forget . . . that in nature nothing is wasted or lost, but merely converted." But a little later *he* makes the remark: "The difference then between very soft iron and hard steel so far as *magnetic waste* goes, &c." Prof. Thomson also "seems to forget that *loss*, *waste* and such terms are more scientifically rendered by the words 'conversion into heat,' and that in nature nothing is wasted or lost, but merely converted."

I most politely decline the "consistently" amended statement. If Prof. Thomson would have said, that *loss*, *waste* and such terms are more scientifically rendered by the word *conversion*, I would have agreed with him; but I cannot agree as to the expression, conversion *into heat*. When on a bright, but cold, winter's day one steps into his office and finds no coal in the stove, and switches on the current of a dynamo to a bank of incandescent lamps with the main object of warming up the room, then all the energy that appears as light is *waste*; or, if this distinction which I make is not made by Prof. Thomson, then I will cite the example of a thermo-dynamic engine in which, besides the *loss* in heat there are *losses* in chemical affinities, light, mechanical motion, electricity and magnetism. Everybody must admit that since Prof. Thomson wants to be so eminently scientific it is immaterial for the present consideration whether the *loss* amounts to one or a million units. This being so, I must confess that I fail to see the advantage of substituting for an unscientific but *correct* expression a scientific but *incorrect* one.

After *consistently amending* my statement, he says: "Heat action is that swinging back and forth referred to, namely, 'molecular vibration,' and if we find that such swinging takes place we must have heat as a result. When the molecules can polarise or turn without being given a swinging movement or vibration, no conversion into heat takes place." If Prof. Thomson means to convey the idea that heat action is such a movement of the molecules, which is accompanied by a local displacement of the centres of the molecules, then, considering the existing uncertainty as to the character of *that* movement of the molecules which constitutes heat, he would do a valuable service to science if he would *prove* his view. There is hope that he will do so, for he says: "If we *find* that such movement takes place, &c.," whence I infer that he must have *observed* it. Then, again, if we conceive a swinging or vibration without displacement of the centres of the molecules, such as the swinging or vibration of a magnetic needle, for instance—an improbable, but not impossible, movement—according to Prof. Thomson, "no conversion into heat" would take place. Yet such movement would be a movement of material particles *in* or *through* matter, and would represent energy. If the movement be arrested in any manner, then the energy of this movement would be transferred or converted into another kind of movement or form of energy; and since Prof. Thomson says that it would not appear as heat, then in the sentence, "no conversion into heat takes plates," the word "heat" ought to have been emphasised.

As to the statement, "When the molecules can polarise without being given a swinging movement or vibration," I must admit that with my weak intellectual powers I cannot perceive how in the world they *can* polarise without a swinging movement or vibration; but I can easily see that they can *be polarised* (for any length of time) without a swinging movement or vibration. However, Prof. Thomson may be able to explain.

Prof. Thomson further says: "Heat action is that swinging back and forth referred to, &c." The swinging back and forth referred to by me is that *assumed* angular and local displacement of the molecules which is directly produced by the reversals of the current in the coil energising the core, and which may be effected, say, 250 times a second. Since, according to Prof. Thomson himself, not *any* movement but a *particular* movement or mode of motion of the molecules constitutes heat, then, instead of saying, "heat action is that swinging back and forth referred to, &c.," would it not be more correct to say that the energy of these comparatively few "back and forth" movements of the molecules is converted into heat by increasing the amplitude or number per unit of time, or both, of the original vibrations of the molecules?

After stating that, "when the molecules can polarise or turn without being given a swinging movement or vibration, no conversion into heat takes place," Prof. Thomson says: "In like manner, bending a bar of tempered steel back and forth within limits is mechanically efficient, because *very little conversion of motion into heat takes place*, and this is a result of the *relative positions of the molecules being preserved*, &c." Then, after all, there is *some*, however small, conversion into heat, though, according to Prof. Thomson, there ought not to be *any*, since no swinging movement or vibration back and forth is imparted to the molecules, their relative positions being preserved.

Then comes the statement: "The difference between very soft iron and hard steel, so far as *magnetic waste* goes, is, apparently, that in the soft iron there is less disturbance of position of the molecules during magnetisation and reversal than in steel, assuming the degree of magnetisation or polarisation to be equal in each." The italics are mine. While this *ex-professo* assumption cannot be contradicted, yet it has very little in its favour, and is not in harmony with the views of the most competent scientists, who prefer to assume that the molecules of steel move with greater stiffness, or, in other words, that, for *the same disturbance of position*, more energy is required in hard steel. Maxwell has shown, theoretically, that in removing a permanently magnetised body to infinity from another magnet, the work done is twice as great as when removing to infinity the same body magnetised inductively to the same degree. Since a weakening and strengthening of the inducing magnet is equivalent to its removal or approach, respectively, we can conclude from this consideration alone that the dissipation into heat will be the greater the longer the molecules are capable of *retaining* the induced *magnetism*, and that under otherwise equal conditions the probable theoretical limit in hard steel will be reached when the dissipation is twice as great as that in wrought iron. Now, this quality of retaining the induced magnetism *is* commonly attributed to the steel molecules. A graphical representation shows at a glance the importance of this lagging of induced magnetism, and makes it appear more probable that this quality of *retaining*, rather than the greater displacement of the molecules, is the cause of the greater dissipation in hard steel.

Prof. Thomson further states: "The *waste* or conversion due to electrical resistance is of the same nature." I hardly need point out the fallacy of this statement. The waste or conversion due to magnetic action is always proportionate to the number of the molecules of the magnetised body; the *waste* or conversion due to electrical resistance is not always proportionate to the number of the molecules of the conductor. Ether is an excellent conductor of magnetism, but may be a conductor, or perfect non-conductor, for an electric current, and the conditions determining this are unknown to us. From this alone it should be concluded that both conversions cannot be of the same nature. But an example will make it clear. Suppose we partly exhaust the air in a Geissler tube, and pass an electric current through the air in the tube; then a certain resistance will be offered to the passage of the current and a certain amount of energy will be converted. Now, we may exhaust more air and at a certain point there will be an increase of resistance. So we may go on until we reach any desired degree of rarefaction. The resistance, and consequently the *waste* due to the same, will continue to increase, yet the disturbance, so far as the air molecules are concerned —since their number will be enormously reduced—will be continually diminishing in amount. Assume the vacuum to be reached, then the resistance may be assumed infinite; there would then be, in the sense of the statements of Prof. Thomson, *no* disturbance, namely, no disturbance of the air molecules, since there are *none* in the tube; yet the *waste* may be anything.

On the other hand, we know from theoretical considerations and practical results, that the "magnetic waste," to quote Prof. Thomson, is, under otherwise equal conditions, strictly proportionate to the number of molecules of the magnetised body.

Then comes the statement: "Whenever the ether strain can be transmitted from molecule to molecule of the conductor, without much disturbance of their positions, or without causing a swinging out of position back and forth, the conductivity is great, and the reverse is true for bad conductors." Since the conductivity is measured according to a common standard, this statement must stand the test of relativity, and then it seems to me to be so evidently erroneous, that it hardly need be contradicted. If we pass a current through a carbon filament, and bring it to incandescence, we cause a certain disturbance of the molecules. If we pass *more* current, we produce a *greater* disturbance in the filament; nevertheless the conductivity is *greater* in the latter case. Prof. Thomson "seems to forget" that the conductivity of a body is determined by two things, namely, the conductivity of the molecules *per se*, and the conductivity of the intermolecular ether. Hence, in passing a current through a conductor, we produce two disturbances—that of the molecules and that of the ether in the space between them; and all who understand the problem of efficient light conversion are trying hard to confine most of the disturbance which may be caused by whatever *is* electric current, or moving electric charge, to the ether. From this it is evident that in some cases we may produce a *greater* disturbance of the molecules of the conductor, and yet have *greater* conductivity, because of the relatively smaller disturbance of the ether, since the conductivity of the conductor, as a whole, is a function of both the conductivities of the molecules and of the ether. The more the ether disturbance is made preponderating, the more efficient will be the light conversion. These facts have evidently escaped the notice of Prof. Thomson. This statement, so far as it applies to bad conductors, is likewise contradicted by the behaviour of a great number of bad conductors which become good conductors under certain conditions. If, in the previous statement, Prof. Thomson means not the integral sum of the disturbance of position of the molecules, but the amplitude of the disturbance, then I only need to cite the example of an incandescent metallic conductor to disprove the general truth of his statement.

Then, again, Prof. Thomson says: "There is then, to my mind, no more difficulty in understanding (conceiving ?) that a conversion into heat may be produced magnetically than electrically, or mechanically." For one so particular in the use of terms as Prof. Thomson, the expression that a conversion into heat may be *produced*, is not a happy one. Conversion into heat may be *effected*, not *produced*.

What I have said above will also have a bearing on a later remark of Prof. Thomson: "It is in my view more legitimate to attribute the heating effects of Foucault currents and other currents to a general molecular friction or hysteresis of conduction, if we may use such a term, than to assume the production of molecular currents in the heating or conversion of magnetic hysteresis," in which he treats the question of hysteresis *homeopathically*, as it were. There occur in Prof. Thomson's letter expressions like "transmission of ether strains," "reducible to a single effect," &c., and some other contradictions which I have no time to comment on, but which will be observed by the careful reader.

Prof. Thomson concludes with the truly philosophical statement that we neither need to assume, nor can we deny, the formation of molecular currents—and the reader is no wiser than before.

Nothing, however ably said or written, is unapproachable to criticism. A slip of the tongue in an *extempore* discussion, or a slip of the pen in a hurried letter, can easily occur; but a fair-minded critic will make allowance for this, and will not fall into the faults of pedantry and cavilling. But if one, without cause, makes himself guilty of these faults he ought to be dealt with in a like manner. If one is exacting he ought to take care to be exact himself. The error of one who makes an incorrect statement is not nearly as great as that of him who attempts to point out the error, and is in error himself. But, above all, one so liable himself to mistake ought not to assume the role of tutorship.

New York City. NIKOLA TESLA.

ELECTRIC LIGHTING OF NEW SCOTLAND YARD.

THE new central offices of the Metropolitan Police on the Embankment are being fitted throughout with the electric light. Altogether some 1,260 incandescent lamps will be employed to light the 300 rooms and multitudinous corridors and passages. In order to obviate any risk of a total extinction of the light from any cause, the wiring, which will require altogether about 15 miles of conductor, is arranged with alternate lamps on different circuits supplied by separate engines and dynamos, and a special feature will be the arrangement of the lights in the various offices in each of which all the connections will be made with twin flexible conductors which will start from a distributing box over the door and run separately to the pendant lamps across the ceilings on the surface of the plaster, the twin cables being held in place by small insulating eyes. This arrangement has been specially designed to suit the construction of the building, in which all the floors are of the parquet description laid on solid concrete, and the exigencies of the police requirements which necessitate from time to time alterations in the positions of the lights.

It was at one time proposed to obtain current from one of the public supply companies, but having regard to the large size of the installation and the importance of the lighting being entirely independent of labour disputes or such other troubles as might affect an outside source of supply, it has now been determined to put down a special generating plant with which, on the considerable scale required, it will be possible to manufacture the electric energy at a price considerably below the 7½d. per unit demanded by the supply companies.

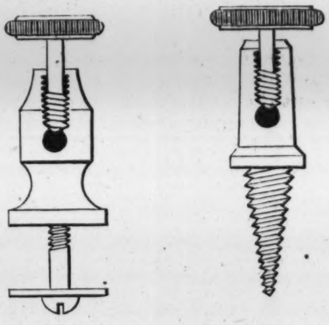
The generating plant will consist of three Lancashire boilers and four sets of engines and dynamos, having a combined power of some 160 electrical horse-power, and will be placed in a special underground engine house excavated outside the main building, so as to avoid the possibility of the noise or heat causing any nuisance in the latter.

There will also be a battery of accumulators capable of maintaining 200 lights for nine hours when the engines are at rest.

The installation, which will be one of the largest and most complete of the kind in London, is being carried out to the specification of Mr. A. A. Campbell Swinton, A.M.I.C.E., who has been appointed by the Home Office to superintend the whole undertaking.

A PEACE-MAKING BINDING POST.

NEARLY everyone, says the *Electrical World*, that has had anything to do with electrical instruments knows what it is to lose binding post screws—generally at the most inopportune and inconvenient moment. When one is standing over an instrument with a wire in each hand, and a screw sees fit to tumble out and drop into a crack in the floor, the effect on the average man is to produce anything but amiability. In shipping instruments, too, it not unfrequently happens that an instrument turns up at its destination minus this small but very necessary part.



The improved binding post shown herewith has just been brought out by the E. S. Greely & Co., of New York, with a view of obviating this slight but exasperating difficulty. The screw of the new binding post cannot come out, but it backs up just far enough to clear the hole. The thread of the screw is on a shoulder larger than the stem, and, as the neck of the key is turned tight up to the stem, the screw part cannot pass.

The binding posts look like the ordinary kind—made in all sizes and shapes. For many purposes they must come into extensive use, for the convenience of the device is evident at a glance. One great advantage that is secured is, that when wiring has to be done in dark, out-of-the-way places, one can know precisely when the wire hole is clear, and can work without danger of losing the screw in the very darkest corner. It is certainly a meritorious and convenient modification of the forms in ordinary use.

THE ROYAL BOTANICAL GARDENS, MANCHESTER.

FOLLOWING on the success of the concerts in these gardens during the progress of the Royal Jubilee Exhibition of 1887, the direction have had during the past two years, in the summer months, a series of afternoon and evening concerts, held in the open air, where military and volunteer bands have been engaged, and in the concert hall (a relic of the old exhibition), where vocalists and instrumentalists attracted large audiences. The electric light, having formed so important a feature in the success of the exhibition, was called into requisition for the illumination of the grounds and concert hall under the new arrangement of the Horticultural Society. An installation of arc lights was completed, and has been used during the past two years; this was described at the time in our columns. This installation did not, however, meet with general approval, from causes unnecessary to mention here, and for the present season (which has now just commenced) an entirely different system of lighting was determined upon. The old plant was removed, and the contract for the re-lighting of the whole of the gardens, concert rooms and approaches given to Mr. S. H. Heywood, A.I.E.E., electrical engineer, of Brasenose Street, Manchester. The system adopted is the Thomson-Houston, which has, under similar circumstances, given general satisfaction.

There are two circuits employed, each carrying 21 Thomson-Houston arc lamps of the usual type; these are suspended from masts in the grounds, and from the roof of the band stand, and in the concert room and approaches they are suspended from the roofs, at a distance apart from one another to give an equal and efficient light. In the old dynamo room there are fixed two 30-light Thomson-Houston dynamos of the latest pattern: these, by means of counter-shafting, are driven by a Ruston-Proctor engine of 25 H.P. nominal. The circuits are arranged with switches, so that they can be run from either machine. The success of the new lighting arrangements on the first evening of the concert season was very marked, the lights being well maintained, and perfectly steady throughout the whole of the time. The light was very evenly distributed, and the lamps arranged at such a height as not to prove too strong for the vision. The installation has been well carried out, and reflects credit upon the energy and promptness displayed by the engineer, Mr. S. Heywood, who was somewhat pressed by the limited time allowed for carrying out the work. Mr. Heywood has been for some years engaged in electric lighting, and has for some little period been carrying on business on his own account, having done already some excellent work. The present installation being of an important character, will greatly add to his reputation and success.

THE RELATION BETWEEN FIRE INSURANCE AND ELECTRIC INTERESTS FROM THE UNDERWRITERS' STANDPOINT.

IN a recent paper read at a dinner given by the Boston Electric Club to the American Institute of Electrical Engineers, Mr. S. P. Barton made some interesting and significant remarks with reference to the relation between fire insurance and electric interests from the underwriters' standpoint. First, referring to a report of a meeting of the National Board of Fire Underwriters in New York, at which it was stated that while electric wires and lights were responsible for losses of only $480,000 in 1886, the value of property injured by fire which could be traced to the same source in 1889 was $5,533,000, Mr. Barton points out the misleading character of the bald statement, as the latter would apparently indicate that the danger of fire from electrical causes had grown to be twelve times greater in 1889 than it was in 1886; but a careful examination of the figures puts a decidedly different complexion on the facts.

The tables show that in 1886 there were 29 fires from "electric wires and lights," causing a loss of $450,000; in 1887, 66 fires and $881,000 loss; in 1888, 91 fires, with $1,587,000 loss; and in 1889, 74 fires with $5,533,000 loss. The yearly increase in the *number* of fires reported is nowhere near the percentage of increase in the use of electric lights and wires, and therefore the number of fires was not used to show the comparative hazard by years. It looked much more startling to use the amount of loss, and for that reason it was probably used. But where, says Mr. Barton, did the great increase in amount of loss come from? Why! from the Boston fire of last thanksgiving day, which "everybody says was caused by the electric wires," but which *nobody* has proved. The fire marshal in his investigation exhausted his energies and all means at his disposal, and certainly the bulk of the testimony taken would naturally lean towards fixing it upon the electric wires. The Massachusetts Insurance Commissioner, in his 1889 report, just issued, says, "the preponderance of the testimony seems in favour of the theory that it was caused by the electric wires;" therefore, in his opinion (which is good enough for me), it is a "theory that confronts us and not a condition nor a fact. That loss amounted to about three millions and a half. It was injected into the destruction account of "electric wires and lights," making the account four times as large as in 1888, and yet, admitting the right to charge the fire to that account at all, it only increased the number of accidents by one. Supposing the fire had got still further beyond the control of the firemen, and had destroyed one hundred millions instead of three and a half, of course it would have proved (according to the logic of the report of the National Board) that electricity is twenty-two times as hazardous as the report makes it out to be.

Taking a few comparative figures for the whole country, taken from the Chronicle Fire Tables for the year 1888, we find:—

In clothing stores the whole number of fires reported is, for the year, 1,072, 28 of which came from gas jets, 21 from lamps exploding, 9 from lamp accidents, 3 from gas explosions, 13 from matches—in all 74, as against 6 from electric lights and 9 from electric wires.

In country and general merchandise stores 4,847 fires are reported, of which 39 came from lamp explosions, 8 from lamp accidents, 3 from gas jets, 20 from matches—in all 70, as against 1 from electric wires.

In crockery and glassware stores 179 fires are reported, of which 8 came from lamp explosions, 7 from lamp accidents, 3 from gas jets, 4 from matches—in all 22, as against 1 from electric wires.

In dry goods stores 1,858 fires are reported, 123 of which came from gas jets, 34 from lamp explosions, 6 from lamp accidents, 7 from gas explosions, 19 from matches—in all 197, as against 10 from electric wires and 3 from electric lights.

In fancy goods stores 519 fires are reported, 28 of which came from lamp explosions, 7 from lamp accidents, 27 from gas jets, 9 from matches, 2 from candles—in all 73, as against 4 from electric wires.

In the United States in 1888 the whole number of fires from the above-named causes is reported as follows:—Lamp and lantern explosions, 528; lamp and lantern accidents, 190; gas jets, 179; gas explosions, 63; matches, 592—in all 1,552, as against 49 from electric lights and wires.

There were 53 from stationary engines and boilers, and that number, though small, can be reduced just as fast as the electric motor takes the place of the boiler and stationary engine.

Of the 31 fires that were reported in electric light stations in 1888, 11 were from exposure to other risks, 4 were from unknown causes, 5 were from causes not reported, 1 each from engine, furnace, spontaneous combustion, lightning and explosion, while 6 came from "electric wires," showing that after all it is not the mysterious electric current nor the pranky wire that are responsible for the havoc, but that the ordinary causes that pertain to other risks, such as improper location, contiguity to bad neighbours, and carelessness of various kinds, are the chief sources of danger.

In seven years previous to and including 1888, 80 fires are reported in electric light stations—about 11 per year on the average.

In conclusion, Mr. Barton remarks, "on the whole, I don't know what the relation between the interests is, from the underwriter's standpoint. What are his views to-day may not be to-morrow. There is no hazard that underwriters, as a rule, have made so little effort to understand, and consequently they are too largely guided by the caprice of popular prejudices and beliefs, neglecting to carefully study their tables of experience, and be guided by the logic of events. There is also no hazard around which they have ever thrown so many restrictions."

There is a saying that "anything can be proved by figures." This, of course, is only true if the figures are dealt with regardless of logic; but facts are facts, and in the case of the electric light we think that a logical conclusion to be drawn from the statistics will only lead to one conclusion, and that is, that of all methods of illumination the electric light is by far the safest.

NOTES.

Electric Lighting by Gas Companies.—The following shows the number of gas companies operating electric lights in America, given in "Brown's Gas Directory for 1890":—

	1889.	1890.
Number of gas companies operating electric lights...	266	304
Number of different electric light systems used	21	23
Number of arc lights operated ...	21,313	31,558
Number of incandescent lights operated	55,890	132,771

Electric Lighting in Roumania.—The Minister for Home Affairs has introduced to the Chamber a Bill, according to which the town of Krajova is authorised to give to Messrs. B. Egger & Co., of Vienna, the concession for the electric lighting of that town for 45 years. The town authorities undertake to subscribe for 800 incandescent lamps per diem. The price will be ⅜th of a penny per lamp-hour to the town, and ⅝th of a penny to private consumers.

The Electric Light in Strasburg.—A lively state of affairs is prevailing at Strasburg, in Alsace-Lorraine. The supply of gas is in the hands of a French company, the Union des Gaz, who, according to a contract made with the town in 1885, have the exclusive right of laying gas mains. As electric lighting is progressing in other towns the Municipality recently appointed a committee to decide the powers of the gas company. The committee, in its report, finds that the gas company has only a monopoly for public lighting, and that, according to the contract, the Town Council may experiment with any new light. The latter has, therefore, resolved to spend £1,600 in experimenting with the electric light by means of underground cables. In the meantime a concession has been given to the local electrical works to put up private installations, but this will lapse when the town has erected its own station.

The Lighting of Brussels.—The commission appointed by the Communal Council to report upon the various proposals made for the lighting of the city by electricity, has reported against them all on financial grounds. Fresh offers are invited and should none be found satisfactory the authorities will, it is expected, undertake the lighting.

The Tivoli Theatre of Varieties.—One of the best variety entertainments in London is provided at this theatre, which is situated in the Strand, and is lighted throughout by electricity. The current is suppled from Messrs. Gatti's station on the opposite side of the Strand. Instead of suspending from the glass roof or ceiling a large electrolier, a number of incandescent lamps have been arranged in five rows, this giving an exceedingly pretty effect. In other parts of the theatre brackets, pendants and electroliers are employed. Outside the hall are suspended five arc lamps of high candle-power, making the position of the theatre visible at some distance. Both the installation and the entertainment are well worth seeing.

Central London Railway Bill.—As we anticipated in our last issue, an attempt was made in the House of Commons last Friday to postpone the reading of this Bill. The arguments of the shopkeepers were abandoned at the last moment, and attacks were made upon the system of traction it is proposed to employ. As Sir Julian Goldsmid said, there was never a weaker case submitted for upsetting the deliberate judgment of a committee, which had sat for a long period, and had given the closest attention to evidence for and against the scheme. Finally the Bill was ordered for the third reading.

Field Telegraphy.—An ingenious invention, which is considered to constitute a distinct advance in field telegraphy, has recently been patented by Mr. Jerritt, A.I.E.E., of Plymouth. The new instrument has been christened the "Combination Military Telegraphic Field Sounder," and is so arranged as to be capable of being used as a transmitter and receiver. The lever of the sounder may be employed for sending as well as for receiving messages, the current being turned on and off by means of a small switch fixed to the base of the instrument. In case of a diminution of current, from any cause whatever, a telephonic arrangement can be adjusted for receiving purposes. The instrument, battery, sounding box, and telescopic stand can be folded up so as to form a neat knapsack, which no operator would object to carry. The centre of the stand may be used as a drum for coiling a quantity of wire.

A Loan for Electric Traction.—The Bill promoted by the North Metropolitan Tramway Company, empowering it to use electrical power on its system, and to raise £125,000 additional share and loan capital, was sanctioned this week by Lord Morley's Committee of the House of Lords. The Bill has now been passed by both Houses.

Orders Granted to Lancashire Corporations.—The Board of Trade has granted provisional orders to the corporations of Accrington, Blackpool, Burnley, Bury, Lancaster, and Salford for the electric lighting of these boroughs. The board has also granted an order empowering the Fleetwood Improvement Commissioners to light with electric light the urban sanitary district of Fleetwood.

Electric Traction in Boston, Mass.—A friend of ours who attended the recent annual meeting of the American Institute of Electrical Engineers writes to say that there are now 200 electric tramcars in daily operation in the city of Boston alone.

Accidents from Touching Electric Wires.—A man was killed at Baltimore on Saturday through touching an incandescent electric light wire. Another, who touched the body of the dead man, was knocked down and rendered insensible, but he subsequently recovered. We presume that the incandescent lamps were working on a high tension transformer system, and that the primaries and secondaries came into contact in some unexplained way. A similar accident occurred at New York on the same day, a man being seriously injured.

London Fire Brigade and Telephonic Communication.—At the London County Council last Tuesday, Mr. Nathan Moss (chairman of the Fire Brigade Committee) reported agreements in duplicate between the Council and the Post Office with respect to the maintenance of telephone communication between the new Manchester Square station and the chief station of the Brigade, and the stations in the A district. The sums quoted are the annual rents payable, in respect of which an estimate was approved by the Council on 25th February last—

Manchester Square and	Head-quarters	£41	15
do.	Westminster	32	15
do.	Fulham	57	10
do.	Brompton	44	0
do.	Chelsea	35	0
do.	Hammersmith	50	15
do.	Knightsbridge	30	10
do.	Kensington	37	5
do.	Notting Hill	35	0
do.	North Kensington ...	44	0
do.	Paddington	26	0
do.	St. John's Wood ...	50	15
do.	Hampstead	55	5
do.	Pimlico floating station	44	0

The committee recommended, and it was resolved :—"That the seal of the Council be affixed to one part to each of the said agreements."

Proposed Great Extension of Electric Mains.—The Highways Committee of the Council made the following report, and recommended that, so far as regarded streets and places under their jurisdiction, sanction should be given to the proposed works :—"The Metropolitan Electric Supply Company has given a notice (registered No. 88), dated 28th May, 1890, accompanied by three plans, of intention to lay mains in Great Quebec Street, John Street North, Wyndham Street and Place, Circus Street, Harewood Street, Lisson Grove North, Bryanston Square and Place, Seymour Place, Stafford Street, Harcourt Street, Homer Street and Row, Shouldham Street, Brown Street, Molyneux Street, Newnham Street, George Street, William Street, Charles Street, Great and Little James Streets, Lisson Street, Upper Lisson Street, Carlisle Street, Manning Street, Burne Street, Edgware Road, Harewood Square and Place, Melcombe Place, New Church Street, East Street, Devonshire Street, Bell Street, Harrow Street, Hereford Street, Mitcham Street, Chapel Street, Marylebone Road, John Street, Upper York Street, Crawford Street, Upper Dorset Street, Queen Street, Mitford Place, Cleveland Street, Cirencester Place, Bolsover Street, Great Portland Street, Charlotte Street, Portland Place, Buckingham Street, Park Square and Crescent, St. Andrew's Place, Albany Street, Harley Street, Devonshire Place, Brunswick Place, High Street, York Gate and Terrace, Allsopp Place, Upper Baker Street, Park Street and Road, Dorset Square, Street, and Place, Nottingham Place, Northumberland Street, Outer and Inner Circles, Upper Park Place, New Street, Sussex Place, Earl Street West, Milton Street, Stephen Street, Union Street and Place. These works are of the same description as those of this company previously sanctioned by the Council, and there seems to be no objection to them. Some of the places specified in the notice, however, such as the Outer and Inner Circles, Regent's Park, are the property of the Crown, and to these it is not clear that the Council's jurisdiction with reference to electric lighting extends."

Alternating Current Arc Lamps. — There appears to be still a difference of opinion as to the efficiency of alternating current arc lamps; much of course depends upon the position of the lamp and the arrangement of its reflectors, for as the lower carbon throws its light upwards and the upper one downwards, a lamp placed high up requires to have all the rays cast down as much as possible. But apart from this question, there is the question whether the sum of the two lights from the two carbons is equal to the light which the single carbon would give with a direct current of the same energy. The question ought to be an easy one to settle, but it requires to be settled.

Question about Overhead Wires in the House of Commons.—Mr. Dixon-Hartland asked the Attorney-General on Monday whether the new electric light companies in London were legally empowered to disfigure the streets and greatly increase the risks of fires by putting their wires overhead instead of underground. The Attorney-General: Under the Electric Lighting Acts of 1882 and 1888 powers are reserved to the County Council and to the Board of Trade for regulating and controlling the cases in which overhead wires may be used, and, in my opinion, these powers are sufficient. The information before me does not tend to show that overhead wires increase the risk of fires.

Lighting of Wimbledon by Electricity. — The Wimbledon Local Board has decided to light the town by means of electricity, in place of the present system of oil lamps. The sum required for the installation, according to the estimate of Mr. W. H. Preece, of the Post Office, will be £30,000, and the Board has applied to the Local Government Board for power to borrow this amount. The scheme has met with strong opposition from a section of the community.

Transmission of Power by Electricity.—The Società Aguedotto Deferrari-Galliera recently inaugurated its new station for the transmission of power by electricity, in the presence of the civil and political authorities, members of the press, scientific and commercial bodies, and others. This is the second to be established in the kingdom of Italy, that of Alzano-Maggiore being the first.

Successful Sea Trial of the Fiske Range Finder.—An American contemporary says of the Fiske range finder, recently described in the columns of the REVIEW:—During the recent trial trip of the cruiser *Baltimore*, with a board of inspection on board, the new Fiske range finder was given a thorough test, and the results were highly satisfactory. The targets were placed at ranges varying from 1,350 to 2,000 yards. The practice would have been entirely satisfactory for gun captains who had had two or three years' experience with their weapons, but, when it is considered that the captains of the guns were firing their first shots with the modern breech-loading gun, the results were very remarkable. The firing was declared by the ordnance experts on board to be closer than is ordinarily attained after months of practice. This result is due almost entirely to the range finder. The captains of the guns were enabled to know at any moment the exact distance of the target.

Southend Pier Tramway.—We learn that the contract for the electric tramway system on Southend Pier has been definitely handed over to Messrs. Crompton & Co. It is to be regretted that more publicity has not been given to the proceedings of the Southend Local Board in this matter, for we do not understand that the work was advertised for competition, a course which would probably have been more satisfactory to electric traction firms generally and to the Southend ratepayers.

Heavy Costs.—We understand that the costs of the proceedings between Messrs. Crompton & Co. *v.* the Elieson Electric Company, which lasted five days, have to be borne by the former. It seems a great pity that the matter could not have been settled out of court; friendly arbitration before some gentleman acceptable to both parties would have saved hundreds of pounds.

Reduction in the Charge for Cablegrams.—Notification has been given by Mr. Fuller and Major Wood, the respective representatives of the Brazilian Telegraph and Cable Companies, to the International Telegraph Conference now sitting in Paris, that a reduction of 50 per cent. will be made from the 1st July next upon Press messages (subject to the usual regulations governing the transmission of this class of correspondence) to and from the East Coast of South America.

A Messenger System for London.—Messrs. P. B. Lyon and R. King, managing directors of the "Boy Messengers' Company, Limited," have just issued an appeal asking the public to petition the Postmaster-General to favourably consider the application which the company has made for a license to enable it to introduce into London a messenger call system similar to that now in existence in the principal American cities. Messrs. Lyon and King state that there is a great demand for such a system; but, in face of the fact that the Exchange Telegraph Company have for some years had a similar one in existence, and have met with but poor success, the correctness of their statement would seem questionable.

The Control of Overhead Wires in London.—A Committee of the House of Commons began a sitting on Wednesday to consider the Bill promoted by the County Council for the controlling of the overhead wires in London.

An Electric Light Company for the Isle of Man.—A company has been registered in the Isle of Man, with a capital of £25,000, to carry on the business of an electric light company.

The Compound Winding Case.—We think it is pretty evident that a better advocate than Mr. Murray for the claims of Mr. Varley could not readily be found. The arguments in this interesting case will be found very entertaining reading.

Price of Copper.—Messrs. F. Smith & Co. inform us that their price for high conductivity copper wire has advanced ½d. per lb., making present basis price 9½d. per lb. for Nos. 0 to 20.

Henley Cables.—We hear that Messrs. W. T. Henley's telegraph works are fully occupied on important cables. One of these is to be laid to Port-au-Prince from Cape St. Nicholas (Haiti), a length of about 120 knots. Another is 800 knots in length, and intended for laying between the Guianas and the West Indies. The company is also engaged upon an order from the Canadian Government for a short length of cable with Henley's Ozokerit India-rubber core. Some of this cable was supplied to that government eight or ten years since, and the second order is an indication that the cable has given satisfaction during a lengthened experience.

Rashleigh Phipps and Dawson.—The elaborate fittings in the new Tivoli Theatre and Restaurant, Strand, which have been well spoken of by good judges both of design and execution, were the work of Messrs. Rashleigh Phipps and Dawson. We believe that the whole of the various fittings were designed by the firm's own artists, and manufactured in their own workshops within the short space of two weeks. At the showrooms of this firm may now be seen a most extensive and artistic display of fittings specially designed for electric lighting, an illustrated catalogue of which is now partly ready.

The Lane-Fox Patents.—It would be interesting to know what attitude the electrical trade will take with regard to the Lane-Fox patents, and still more so to see what effect the company's manifesto will have upon private consumers. If once this kind of proceeding gains ground there is no knowing to what extent the suppliers of electricity will be hampered by such embargoes upon their business. The object of everybody should be to do everything possible to lessen the cost of electric lighting, for it is dear enough in all conscience. In the meantime the gas companies can watch events with complacence.

Personal.—Mr. Abion T. Snell, M.I.E.E., M.Inst.C.E., has been appointed works' manager and chief engineer to the General Electric Power and Traction Company, Limited.

Robbery.—At the County of London Sessions, Joseph Jefferies, 53, Arthur Hewlett, 28, Nathaniel Fenn, 40, and William Price, 38, were indicted for stealing a quantity of platinum, value £800, the goods of the Brush Electrical Engineering Company, and for receiving the same well knowing it to have been stolen. Mr. Avory prosecuted; Mr. Lawless defended Fenn and Price. Hewlett, Fenn, and Price pleaded that they were guilty of stealing 69 ounces, and Jefferies that he received the 69 ounces, but without guilty knowledge. The indictment being in respect of 400 ounces, the prisoners were placed on their trial for stealing the residue. Hewlett, Fenn, and Price were workmen in the employ of the Brush Electrical Engineering Company, and evidence was given tracing the disposal of 69 ounces of platinum, it being alleged that they with the prisoner Jefferies were concerned in the matter. The men were suspected and accused of stealing the platinum, and, when taken into custody, they made statements implicating each other. A portion of the proceeds of the sale of the 69 ounces was found on Jefferies, who had also placed £20 in the Post Office Savings Bank. The learned Chairman, in summing up the case, remarked that it was an unusual course to try the prisoners on an indictment to a portion of which they had pleaded guilty, and the jury must be quite satisfied that the evidence sustained the charge before they found them guilty of stealing the 400 ounces. The jury found the prisoners not guilty of stealing the residue. Witnesses as to character were called on behalf of Price. The learned Chairman, at the request of counsel for the prosecution, postponed sentence until next sessions, and ordered that the platinum be given up to the Brush Company. The grand jury had commended Dectective-Serjeant Ward and the other detectives engaged in the case for the zeal and ability which they had shown; and Sir P. Edlin said that he quite endorsed that commendation.

Electric Traction at Liverpool.—The Electric Traction Company has completed an installation for the Liverpool United Tramways, and on Monday last the first experimental run was made. The car has been specially equipped to meet the heavy gradients and proved entirely successful; mounting up Water Street with perfect ease, and traversing the whole route of the Walton and pierhead line. Sir David Radcliffe, the chairman, and other directors and officials of the line were present, and expressed their satisfaction. The experiment was made under the guidance of the Company's engineer, Mr. Thos. Frazer.

Electrical Trades' Section of the London Chamber of Commerce.—A meeting of the Electrical Trades' Committee will be held at Botolph House on Monday next, the 16th instant, at 2.30 p.m., to consider the continuation of the correspondent's appointment, salary, &c.; action of the Board of Trade in regard to overhead wires; statistics as to the volume of electrical trade in the United Kingdom, and other matters.

Lamp-holder Patents.—Not satisfied with the claims made on behalf of the "feeder" patent, the Edison-Swan Company is now threatening firms manufacturing incandescent lamp-holders. When is this tyranny going to end?

Charlesworth, Hall and Company.—This firm has just issued a new price list of dynamos (Sheet A. N.) cancelling all previous lists.

Electric Launches at Edinburgh.—The result of the first week's running of the electric launches on the Union Canal, to and from the Edinburgh Exhibition, has exceeded all expectations. Notwithstanding three wet days, and sometimes only two boats plying, the receipts amounted to over £100, and 6,500 passengers were carried.

Kemmler's Fate.—Whether the convict Kemmler should be electrocutionised or strangled plain, or will eventually shuffle off his mortal coil in bed, possibly "babbling o' green fields," like any other rogue, is being keenly canvassed on the other side of the "herring pond." Electricians, they say, are deeply gratified that the constitutionality of the scientific method will be again questioned. Another "subject," McElvaine, of Brooklyn, has obtained a new trial, and thus temporarily escaped the fate prepared for him. The New York *Electrical World* thinks, under the circumstances, murder will be a safe occupation for the next few years.

The Financial Critic.—*Money*, in a recent issue, holds forth in the following manner: "Who or what is the Ward Electric Car Company, Limited, of 38, Gracechurch Street, E.C.? We do not remember the company being registered, and yet it seems to have suddenly sprung into existence. It has been with the object of starting a service of electric 'buses that the Ward Electric Car Company, Limited, has been formed, though the name seems to be a misnomer, and the first six 'buses are to commence running from King's Cross to Charing Cross in a few months. The idea of running electric omnibuses carrying accumulators is absurd in face of what little has been done with accumulator traction on tram lines in England. When it is considered that nearly the same dead weight will have to be borne by the proposed electric 'buses, that a greater tractive power is required to propel the vehicle along a rough uneven road, and that the 'bus will frequently have to "zigzag," owing to the conditions of the traffic, thus causing a strain, it is difficult to see how the omnibuses can be made to pay. In fact, we assert that there is not a single person who can demonstrate that accumulator traction at present is a commercial success in England. We could, if necessary, prove it to be a failure."

A Luminous Sign Board.—The application of electricity to advertising is ingeniously illustrated at the well-known Horseshoe Tavern, Tottenham Court Road, where a sign is being erected in the shape of a colossal horseshoe for illumination by electricity. The horseshoe is made of bent American elm, hollow, and studded on each side with large lenses, exactly opposite each other. Between the lenses Edison lamps are placed. The sign is eight feet nine inches high and eight feet wide at its greatest breadth. It contains 32 lamps of 8 candle-power, fed by 19 strands of 16 wire. Each lamp is protected by a safety cut-out, and two safety cut-outs are also applied to the mains. The mains are encased in woodwork inside the shoe, which is also protected externally with zinc. The sign occupies a conspicuous position 150 feet above the ground. The work is by Messrs. Frank Suter & Co.

The Scientific Treatment of Water in Steam Boilers.—Under this title, Messrs. Sidney Minns & Co., of Dalston, have issued a pamphlet which would be worth a perusal by every user of steam power. It is generally admitted that the majority of boilers are worked at a disadvantage as to consumption of fuel and durability (more or less great according to circumstances) owing to impurities in the water used, and as it is very desirable to find the least expensive and troublesome remedy. The scientific treatment of the water, according to the impurities found in it by analysis, is the course pursued by the firm named.

NEW COMPANIES REGISTERED.

Allen Everitt and Sons, Limited.—Capital £300,000, in £10 shares, 10,000 of which are £6 per cent. cumulative preference shares. Objects: To take over as a going concern the business of W. E. Everitt, trading as Allen Everitt & Sons, at the Kingston Metal Works and the Stephenson Works, Birmingham, and in London and elsewhere; to carry on business as metal manufacturers, metal workers, wire drawers, electrical engineers, metallurgists, manufacturing chemists, &c. Signatories (with one share each): *R. C. Christie, J.P., Roehampton; *W. E. Everitt and *F. D. Everitt, Broomsgrove; *C. C. Turnbull, Cheltenham; *James Young, C.E., Lowmoor, Bradford; Cowley Lambert, M.P., 23, Albert Gate, S.W.; *E. M. Everitt, Alnechurch. The signatories denoted by an asterisk are the first directors; qualification, 250 shares; remuneration, £1,600 per annum and £15 per cent. upon the net profits after providing for the preference dividend. Messrs. W. E. Everitt and James Young are appointed managing directors. Registered 5th inst. by Carmel, Son & Stubbs, 14, Bloomsbury Square.

Column Printing Telegraph Company, Limited.—Capital £100,000 in £1 shares. Objects: To acquire patent rights in relation to printing telegraph machines. To erect, maintain and work telegraphs, and to transmit telegrams in accordance with the terms of any license granted by the Postmaster-General, or other authority. Signatories (with 1 share each): John Moore, 5, New Bridge Street; W. H. Ashenden, 53, Nunhead Lane; T. J. Bulling, 49, Penshurst Road, N.E.; J. Gennings, 118, Drakefell Road, Nunhead; J. Lanyon, 27, Dalberg Road, Brixton; A. Sanderson, 48, Northwood Road, Highgate; W. P. T. Forbes, Wanstead, Essex. The first directors are the Earl of Wharncliffe, Viscount Lymington, M.P.; the Hon. Arthur Brand, W. H. Halburt, and Roderick Pryor; qualification, £200 in shares; remuneration, £200 per annum each, with £300 extra for the chairman. Registered 5th inst. by Rollit and Sons, 12, Mark Lane. Registered office, 5, New Bridge Street, E.C.

Tabular Frame Wagon Company, Limited.—Capital £200,000 in £1 shares. To manufacture railway and tramway rolling stock, and to acquire patents relating thereto, and to carry on the business of civil, mechanical or electrical engineers. Signatories (with 1 share each): W. L. Greenfields, 8, Shedley Road, Forest Gate; A. J. Gallichan, 4, Mecklenburgh Square; G. A. May, 200, Coldharbour Lane, S.E.; J. H. Gretton, 5, King's Bench Walk; J. R. Hobson, Hanwell; A. Gregory, 114, Blair Street, Bromley; J. Alexander, 5, Crescent Place, W.C. The signatories are to appoint the first directors; qualification, £500 in shares; remuneration, 1,000 guineas per annum, and in addition £50 to each director for each 1 per cent. of profits available for dividend in excess of 10 per cent. per annum. Registered 6th inst. by Johnson, Budd and Johnson, 24, Austin Friars.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Venezuela Telephone and Electrical Appliances, Limited.—An agreement of 6th June with N. J. H. Schotborgh, is supplemental to an agreement of 25th April, and in exercise of the option conferred by the second clause of that agreement, the company will satisfy such part of the consideration as consists of £42,200 of the first mortgage debentures of the company, and £3,140 in fully paid shares, by the payment in cash of £45,344, being the proceeds of the issue of the said debentures and shares; the residue of the said consideration to be satisfied as follows—£12,800 in first mortgage debentures, and £56,865, the balance thereof, in fully paid shares.

Brompton Electric Fittings Company, Limited.—The annual return of this company is made up to the 28th ult., and was registered 2nd inst. The nominal capital is £2,000, in £1 shares. The number of shares taken up is 1,050, upon which the full amount has been called and paid.

Telpherage Company, Limited.—The annual return is made up to the 6th inst., and was filed on the same day. The nominal capital is £50,000, divided into 2,500 "A" and 2,500 "B" shares of £10 each; 1,566 "A" and 1,602 "B" shares are taken up, and upon the former the full amount has been called, the "B" shares taken up being considered as fully paid. The calls paid amount to £16,022 10s., and unpaid to £137 10s. The sum of £362 10s. has been paid upon 50 "A" shares forfeited.

Hastings and St. Leonards-on-Sea Electric Light Company, Limited.—The annual return of this company, made up to the 5th inst., was filed on the 9th inst. The nominal capital is £50,000 in £10 shares. 850 shares are taken up, 167 of which are considered fully paid. Upon 683 shares the full amount has been called, the calls paid amounting to £6,785, and unpaid to £45.

Patent Lithographic Zinc Plate Company, Limited.—An agreement of 22nd March, filed 20th ult., provides for the purchase by this company of the English letters patent No. 6,170, and also the secret of Oskar Kindermann, which he states to be an improvement upon the said patent, relating to improved means of manufacturing zinc plates for lithographic purposes. The consideration is £2,500, payable £1,500 in cash and the balance in shares.

Stanhope Company, Limited.—The annual return of this company, made up to the 13th January, was filed on the 18th April. The nominal capital is £30,000 in £5 shares, the whole of which are taken up. Upon 2,000 shares the full amount is considered as paid up, and upon the remaining 4,000 shares the full amount has been called and paid.

Andrews and Preece, Limited.—An agreement of 27th March, filed on the 6th ult., provides for the purchase by the company of the business of electrical engineers carried on by T. R. Andrews and Messrs. Preece at the Borough Mills, Bradford. The consideration, certain chattels and effects specified in the agreement, shall be such sum as is set forth in the value thereof in the accounts and balance sheet of the said firm at the last general account and stock-taking on the 31st December, 1889, payable in fully-paid ordinary shares. The consideration for the goodwill is £3,000 in fully-paid deferred shares.

CITY NOTES, REPORTS, MEETINGS, &c.

The Berliner Elektricitats-Werke.—Central Station Development.

THE second half of the report on the growth and capacity of the above-named electric lighting station has been compiled by Mr. Arthur Wilke. It contains most interesting statistics regarding the gradual development during the last four years of the supply of electric energy, showing the remarkable variations in consumption of current for every season of the year, weekdays, Sundays, and holidays, as well as the division during the hours of each day. The growth of the aggregate consumption has been especially commented upon; thus during the second half of the year 1885 it amounted to 500,000 ampère-hours, rising gradually until it reached 11,600,000 ampère-hours for the same period in 1889. For every ampère capacity there was a consumption of 250 ampère-hours for the half-year ending 1885, and 483 ampère-hours for the corresponding term of last year, which shows how much more the capacity of the installation has been utilised.

In the early days of this enterprise it was assumed that the electric light would only be adopted as a kind of luxury by certain progressive clients, but experience has since demonstrated that the demand for it is due to a greater extent to its numerous advantages, which cannot be claimed by any other kind of artificial illuminant. Assuming that the increase of demand will continue in the same ratio as heretofore, it has been calculated that the consumption for the years 1890, 1891 and 1892 will approximate the following figures respectively in millions of ampère hours—viz., 29, 40 and 51.

The following table gives the maximum current strength for every month of the year in percentages of the entire capacity of the station, calculated in the year 1888:—

January ...	76 per cent.	July ...	21 per cent.
February ...	73 ,,	August ...	33 ,,
March ...	65 ,,	September...	53 ,,
April ...	61 ,,	October ...	62 ,,
May ...	38 ,,	November ...	65 ,,
June ...	23 ,,	December ...	70 ,,

On certain days the momentary demand has reached as much as 80 per cent. of the entire capacity of the plant. It would appear from the above table that the application of very large dynamos can scarcely be regarded as an advantage from an economical point of view, considering the enormous variations, and the author recommends medium sized machines which shall, as much as possible, be worked at their maximum or most advantageous load.

For convenience of comparison, the consumers are divided into seven classes, and the mean current used has been tabulated for every month since 1885. We extract therefrom the percentages of consumption as they fell to each class during the last year:—

Theatres	10·5 per cent. of the total current
Banks	20 ,, ,,
Shops	25 ,, ,,
Restaurants ...	21 ,, ,,
Hotels	6·5 ,, ,,
Factories	1 ,, ,,
Dwellings ...	3 ,, ,,
Streets	12·5 ,, ,,
Various	·5 ,, ,,

Of great importance is the introduction of electric motors. These are mostly used during the hours when the demand for the electric light is moderate, consequently the increasing consumption for motive power advantageously enhances the earning capacities of the station plant. It is also hoped that in chemical industries electricity will find ever widening applications, so that eventually certain installations may find a practically continuous field of supply.

The capital invested at present amounts to 7,200,000 marks, or nearly 360,000 pounds sterling, employed in the following manner:—

Real estate	2,800,000 marks.
Plant	1,500,000 ,,
Conductors	2,000,000 ,,
Stock	400,000 ,,
Total	6,700,000 marks.

The remaining 500,000 marks form the working capital of the company.

Income and expenditure are given for the last two years in marks.

	1887 1888.	1888-1889.
Income ...	636,823 marks. ...	1,146,009 marks.
Expenses ...	354,329 ,, ...	629,114 ,,
Profit ...	281,494 marks. ...	525,895 marks.

The financial year 1889-90 will probably show an income of over two million marks. Dividends of 7½ and 8 per cent., respectively, have been paid to the shareholders during the past two years. Altogether, the company is in a most prosperous condition, and according to the diagram representing the fluctuations in values, the shares have been at very high premiums, up to 90 per cent. in some recent cases.

Northampton Electric Light Company.

A MEETING of the shareholders of the Northampton Electric Light and Power Company, Limited, was held on Tuesday last week in the Council Chamber of the Town Hall, Mr. S. L. Seckham (director) presided.

The Chairman proposed the acceptance and adoption of the report and statement of accounts read by the secretary, which latter showed:—To share capital, 10,000 shares of £1 each, £10,000; to amount paid on 10,000 shares, £4,850; interest in Union Bank, £14 7s. 6d.; total, £4,864 7s. 6d.; by 10s. per share paid on application and allotment on 9,500 shares, £4,750; on account of 500 shares, £100—£4,850; remaining unpaid on account of 500 shares, £150; by 10s. per share to be called up on the whole 10,000 shares, £5,000—£5,150; altogether, £10,000; by purchase of land in Angel Lane, £920; by land tax redemption, £6 19s. 7d.; by interest on purchase money, £3 2s.; by Board of Trade deposit (to be returned), £1,000; by solicitors' charges on account of formation of company, licence, &c., £300; registration fees and stamp duties, £67 5s.; by Board of Trade licence, £50; by Board of Trade provisional order, £50; by sundry accounts for advertising, printing, stationery, &c., £158 5s. 5d.; brokerage, £110 16s.; £736 6s. 5d.; balance at Union Bank, £2,197 19s. 6d.; total, £4,862 7s. 6d. The report and accounts were adopted.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts or the week ended June 6th, amounted to £4,094.

The Great Northern Telegraph Company, Limited. The receipts for the month of May amounted to £24,000; 1st January—31st May, 1890, £105,800; corresponding months 1889, £106,800; do. 1888, £108,400.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 6th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,143.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (June 5.)	Closing Quotation. (June 12).	Business done during week ending June 12, 1890.	
£					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	98 —101	98 —101		
1,549,160	Anglo-American Telegraph, Limited	Stock	50 — 51	50½— 51½	51¼	50½
2,725,420	Do. do. 6 p. c. Preferred	Stock	86½— 87½	87 — 88	87¾	86¾
2,725,420	Do. do. Deferred	Stock	15½— 16	15½— 16	15⅞	15
130,000	Brazilian Submarine Telegraph, Limited	10	11¾— 12¼	11¾— 12¼	12⅛	11⅞
99,000	Do. do. 5 p. c. Bonds...	100	101 —103	101 —103	102½	....
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	106 —109	106 —109		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416... ...	3	2⅝— 2⅞	2⅝— 2⅞	2¾	2⅝
63,416	Do. do. Preference, Nos. 1 to 63,416 ...	2	1⅞— 2⅛	1⅞— 2⅛		
224,850	Consolidated Telephone Construction and Maintenance, Ltd. ...	14/-	½— ¾xd	½— ¾		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5¼— 5¾	5¼— 5¾		
16,000	Cuba Telegraph, Limited	10	11¾— 12¼	11¾— 12¼	12⅛	...
6,000	Do. do. 10 p. c. Preference	10	17½— 18½	17½— 18½	17 15/16	...
12,931	Direct Spanish Telegraph, Limited ... (£4 only paid)	5	3¾— 4¼	3¾— 4¼		
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10		
60,710	Direct United States Cable, Limited, 1877	20	10⅛— 10⅜	10⅛— 10⅜	10 5/16	10⅛
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13¾— 14¼	13⅞— 14⅛	14⅛	13¾
70,000	Do. 6 p. c. Preference	10	14¾— 15¼	15 — 15½	15⅜	15¼
200,000	Do. 5 p. c. Debs. (1877 issue), repay. Aug., 1899	100	108 —111	108 —111		
1,200,000	Do. 4 p. c. Mortgage Debenture Stock	Stock	107 —110	107 —110	108	107
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	13¾— 14¼	13⅞— 14⅛	14⅛	13 13/16
320,000	Do. 6 p. c. Debentures, repay. February, 1891	100	101 —103	101 —103		
446,100	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. ...	100	103 —106	103 —106		
12,500	Do. 5 p. c. Debentures, 1890, redeem. ann. drawings ...	100	103 —106	103 —106		
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900...	100	102 —105	102 —105		
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4¾— 5¼	4¾— 5¼		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	4¾— 5¼	4¾— 5¼	5 3/16	4 15/16
19,700	Fowler-Waring Cables, Nos. 301 to 20,000 ...(£3 only paid)	5	2¼— 2¾	2¼— 2¾		
180,227	Globe Telegraph and Trust, Limited	10	8⅞— 9⅛	8⅞— 9⅛	9⅛	8⅞
180,042	Do. do. 6 p. c. Preference	10	14⅞— 15⅛	14⅞— 15⅛	15⅞	14⅞
150,000	Great Northern Tel. Company of Copenhagen	10	15¾— 16¼	15¾— 16¼		
40,000	Do. do. 5 p. c. Debs. (issue of 1881) ...	100	102 —105	102 —105		
250,000	Do. do. do. (issue of 1883) ...	100	104 —107	104 —107		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000 ...	10	12 — 13 xd	12 — 13		
5,334	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12 xd	11½— 12½		
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited ...	10	19½— 20½	19½— 20½	19⅞	19¾
200,000	Do. do. 4½ p. c. Deb., 1896...	100	103 —105	103 —105		
17,000	Indo-European Telegraph, Limited...	25	38 — 40	37 — 39		
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7		
100,000	Do. do. do. 6 p. c. Debentures ...	100	107 —110	107 —110		
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000 ...	10	5¼— 5¾	5¼— 5¾	5⅝	...
386,875	National Telephone, Limited, Nos. 1 to 386,875	5	5¾— 6	5¾— 6	6	5 5/16
49,825	Do. New Nos. 386,876 to 436,700	5	5½— 6	5½— 6	5 15/16	5½
15,000	Do. 6 p. c. Cum. 1st Preference	10	12½— 12¾	12½— 13	12⅞	...
15,000	Do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10¼— 10¾	10¼— 10¾		
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	¼— ⅜	¼— ⅜		
9,000	Reuter's, Limited	8	7½— 8	7¾— 8¼		
209,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	¼— ...	¼— ...		
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	3¼— 3¾	3¼— 3¾		
3,381	Submarine Cables Trust	Cert.	110 —116	112 —116	114	...
78,949	Swan United Electric Light, Limited ... (£3½ only paid)	5	5¼— 5¾	5¼— 5¾	5¾	5½
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	44 — 46	46	...
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 — 104		
55,000	United River Plate Telephone, Limited	5	4½— 5	4½— 5	4¾	...
146,000	Do. do. 5 p. c. Debenture Stock... ...	Stock	90 — 94	90 — 94		
100,000	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ..,	100	... ...	... ...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9 — 10	9 — 10		
300,000	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	101	...
30,000	West Coast of America Telegraph, Limited	10	5½— 6½	6½— 7	7	6⅝
150,000	Do. do. do. 8 p. c. Debs, repay. 1902 ...	100	111 —116	111 —116	114½	...
64,572	Western and Brazilian Telegraph, Limited	15	9¾— 10¼	9¾— 10¼	10⅞	9⅞
26,986	Do. do. do. 5 p. c. Cum. Preferred	7½	6¼— 6¾	6¼— 6¾	6⅜	...
26,986	Do. do. do. 5 p. c. Deferred	7½	3½— 4	3½— 4	3¾	3⅝
200,000	Do. do. do. 6 p. c. Debentures "A," 1910...	100	106 —109	106 —109	108	106¾
250,000	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 —107	104 —107		
88,321	West India and Panama Telegraph, Limited	10	2⅜— 2⅝	2⅜— 2⅝		
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11 — 11½	11 — 11½		
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	12½— 13½	12½— 13½		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	$1,000	120 —125	120 —125	123	...
179,300	Do. do. 6 p. c. Sterling Bonds	100	99 —101	99 —101		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1¾— 2¼	1¾— 2¼		

* Subject to Founders Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 6⅞—7⅛.—Electric Construction Corporation (£10 paid), 9¾—10¼.—House-to-House Company (£5 paid), 5—5½.—London Electric Supply Corporation, Ordinary (£5 paid), 2½—3.—Manchester Edison and Swan Company, £9, (£1 paid), 11/- —12/-.

BANK RATE OF DISCOUNT.—3 per cent. (17th April, 1890).

LEGAL.

King, Brown and Co. v. Anglo-American Brush Electric Light Corporation, Limited.

(*Continued from page* 653.)

Thursday, May 29th.

The discussion upon the reclaiming note by the Anglo-American Brush Electric Light Corporation, Limited, against Lord Trayner's interlocutor, reduced their patents, was resumed in the First Division of the Court of Session on Thursday. Mr. Jameson, for the reclaimers, proceeded to read from the evidence in the case to show what was thought of Varley's specification by witnesses skilled in electrical science. He quoted first of all, at great length, from Sir William Thomson's evidence to the effect that if anybody followed the directions in Varley's specification he would produce an unworkable machine. Sir William Thomson's evidence came to this, that Varley presented a specification in which there were a great number of directions as to a particular machine, which on being made would be a useless and unworkable machine founded on erroneous theories with regard to electricity and magnetism. When they came, in the middle of this specification, to the lines regarding the winding that might now be held to describe compound winding. They were not inconsistent with it except as to the first two lines. Reading that now it would be easy for any person to get rid of these two lines and say they were a mistake, but going back to the state of knowledge at the time the machine was made, in Sir William Thomson's opinion, it would put any person off the scent, and, although a person might be led to it as in one passage it was not such a description as to amount to an anticipation of Brush's patent. It was very important with regard to the state of Varley's own mind to consider this matter because he had no conception of what he was doing himself. That was shown by Varley's own evidence because he did not claim this great improvement as he considered he was anticipating. But Sir Wm. Thomson and the other skilled witnesses said Varley's specification had nothing whatever to do with series shunt winding. Mr. Preece and Prof. Perry and Mr. Brush had all given evidence of a very decided nature. Mr. Brush's machine had remained in use until the present day with hardly any modification of its original construction. Now the next thing he asked attention to was the history of Varley's machine and the question of prior use. He contended that it was not proved that this machine was a compound wound machine. There were two wires, certainly, upon the magnets, but they were arranged in such a way that they might be coupled up in a great variety of manners owing to the number of terminals they had in the machine. Accordingly as they were coupled up in one way or another they might either have a series shunt machine or a shunt machine; or perhaps, for all he knew, that machine excited separately by taking a pair of bobbins and putting them on one commutator. Whether that were so or not, he (Mr. Jameson) submitted there was no public user in the proper sense of the word—that this was properly an experimental machine, and that although members of the public witnessed the experiments they came to nothing more. He therefore appealed to the law that merely experimental machines, never brought into regular use, and thrown aside altogether would not be permitted to invalidate a subsequent patent of a useful invention.

The Lord President: If the other side is right in holding that Varley's disclosure was an anticipation of your invention, it does not matter whether it was used afterwards or not.

Mr. Jameson: That is so.

The Lord President: But on the other hand, if it is not a disclosure of something equivalent to your invention, although it is used, that will not interfere with your invention. What bearing has this upon the present case?

Mr. Jameson: This machine was made under Mr. Varley's own superintendence and direction.

The Lord President: But is the machine not constructed according to Varley's specification?

Mr. Jameson: The other side say so, and they found very strongly upon that.

The Lord President: There is no doubt that prior use has a separate chapter in the patent law, but that it is applicable to the same invention I rather doubt.

Mr. Jameson: That is a possible state of matters.

The Lord President: There are cases where I have seen prior inventions and prior use both pleaded, prior use as applied to a different stage from the prior invention.

Mr. Jameson: That is generally the case.

Mr. Murray: If the machine is a compound winding machine and was actually used, it does not matter whether anybody used it afterwards, or not.

The Lord President: Of course if that is the case it would be quite separate, but I do not understand that to be the theory of the pursuer or the Lord Ordinary.

Mr. Murray: If my friend is successful in his theory, Mr. Varley's specification meant nothing at all, and nobody could make anything of it.

Mr. Jameson: Even assuming this specification was intended to disclose series-shunt winding and that this machine was made in conformity with that specification, it is quite possible that my friend would not be able to succeed upon the point of the user of his machine, although I convinced your lordships that the specification taken by itself would not disclose an invention in a practical useful way to the public. He meant generally that the specification did not come up to the requirements, because, although that was in Varley's mind, he did not publish the invention in such a way that the public could derive any practical utility from it. If he were right there the publication went for nothing, but his friend again said that if they had failed to publish their invention in such a way as to make it practically useful to the public and to the profession, yet they made the machine themselves; that Varley understood what was in his mind, and he made a machine and used that machine.

Lord McLaren: If the inventor only understands the specification himself, that will not do for the public.

Mr. Jameson: Well, about this machine, your lordships will find a biography of it——

The Lord President: Not an autobiography. (Laughter.)

Mr. Jameson: If you turn to the evidence of Gorman and others, who were connected with the firm of Siebe, Gorman & Co., at whose works Varley's machine lay for some time, their evidence showed that on all occasions upon which the machine was brought out it was for the purpose of seeing what mechanical requirements were necessary to make the machine go well. It so happened that in a part of Siebe and Gorman's yard, where the machine was situated, there was an ice machine and Varley's machine was used to photograph it. Further, the light being there it was used for the purpose of seeing into a diving tank. These were, however, only experimental runs of this machine with the view of mechanically improving it, and after trying it again and again it was put aside. In short the result was that Mr. Varley became convinced that it was an unworkable machine, because if he had thought it was a machine that would be successful and useful in producing electric light he would have made it public. But instead of doing anything more about it he went away to this gun metal store of Siebe & Gorman's and allowed the machine to remain there from 1877 until 1887 when it was brought out for the purposes of the case against Mr. Brush. That was the history of the machine. As to the machine itself Sir William Thomson and Prof. Perry both said it was plainly an experimental machine on account of the quantity of terminals. Then Mr. Preece, the electrician to the General Post Office, said that Mr. Varley made a series machine in 1866 and exhibited it at the Inventions Exhibition of 1885. Mr. Varley was awarded a gold medal for it but nothing was said about the wonderful discovery of series-shunt he alleged he had made in 1876, nor of the machine which was constructed on that principle. Mr. Jameson contended that he had shown very clearly, not only what sort of machine this was but also what even the inventor thought of it. Mr. Varley did not bring it forward at all at this exhibition of inventions and nothing was heard about it until it was brought out in the Crompton case. Professor Perry in his evidence thought it might be coupled up as a series-shunt and Prof. Silvanus Thompson was of opinion that the mere working of the machine would not show whether this was a series-shunt or not. That was really all that was said about this machine, and it amounted to this, that it was used occasionally in order to see what was needed to make it work properly. Lots of things were tried, and then it was taken out of the road. Varley himself was asked about this, and he gave some excuse about pecuniary affairs. He said he was carrying on experiments with the machine, and also making fresh machines to carry out these experiments. Even by his own confession Varley had begun then with experiments. Now, in connection with that, it was only right where considerations as to the utility of the inventions came in that he should shortly point out to their lordships the history of the Brush machine. In point of fact it had been largely used at home and abroad. Mr. Imray, himself a witness for the pursuers, admitted very candidly that the series-shunt contained the constant potential, and, at all events, the self-regulation. There had been a great deal said about constant potential, but it was nothing more than perfect self-regulation. Mr. Brush brought in this self-regulation to an extent never before approaching to constant potential, which had come to be worth a great deal since the introduction of the incandescent light. The result had been that this machine of Mr. Brush's had been published, and it was taken up by a company, and the machines had been sold, both in this country and America, since 1878, when this patent was taken out. That was all he need say upon the evidence in the case, and the next matter was the question of law applicable to that evidence. As to the law, he had to say, generally, that whatever was essential to the invention must be read out of the prior publication. He submitted that that applied to the present case, as was shown in the evidence, especially of Mr. Preece, the Chief of the Post Office Scientific Department, who pointed out that this compound-winding was a thing that depended upon the way in which the wires were wound, and the way in which they were connected. But the question was whether this patent of Varley's disclosed such specific details of compound winding as to amount to prior publication of this discovery patented by Brush. Now, in considering the question they were entitled to take up Brush's patent. Nothing could be more distinct than Brush's description. As against that they were to take Varley's specification. Although Varley in eight lines of his specification might state something consistent with series shunt, yet he did not disclose it in such a way as to enable any person to distinguish it from the excitation from a separate source, or to disclose to any ordinary scientific reader of that specification at the date that Varley was introducing a new method of winding hitherto unknown, which was to effect a great improvement in the working of the dynamo machine. Brush set forth his object, but there was no object set forth by Varley. Varley's object was the extraordinary one of storing up electricity in the bobbins and the details led to confusion.

The LORD PRESIDENT: I should like to know if the law regarding disclosure in the prior specification is disputed.

Mr. DICKSON, for the pursuers: The defenders say that the disclosure in the original must be as complete as in the final specification, and we think that is carrying it too far.

Mr. JAMESON: I do not carry it so far as that, but it amounts practically to that. The specification certainly must disclose a practicable mode of producing a certain result. Did Varley do that at all? He did not tell how to do it directly, either in the specification or by directions. Varley went on to suggest certain ways of winding the magnets, but he gave no specific directions that would enable a person to carry that knowledge into useful effect. Then they had the most learned electricians in the world telling that the specification was full of misleading information. The result was that no outside person could reckon with confidence on attending to Varley's specification, not even the inventor himself. But Mr. Brush came afterwards and showed the means by which the end could be attained, and according to the law as laid down by Lord Chelmsford he was entitled to the invention, as his machines had been used since with invariable success. On the whole matter of the law, Mr. Jameson submitted that the Brush Company were entitled to a verdict in their favour on the ground that Varley's specification was not an anticipation by prior publication of the invention which was set forth in Hadden's, or Brush's, specification and letters patent, and that for the reason that taking it upon the most favourable view that could be, that part of that description was consistent with series shunt winding, yet he submitted with very considerable confidence that even if they assumed that was in Varley's mind it was at best a very hazy notion; and that he himself did not so disclose it to the public as to enable them to make use of that invention. Comparing it with Brush's specification that was clearly brought out, because the whole invention was shown not only in the specification, but also in the drawings. The only drawing that Varley gave was one that took them away from series shunt. That being so, he did not think it mattered in the least that reading Varley's specification with present day knowledge they were able to say now it would suggest series shunt. Varley did not claim it besides, and he gave the very lame excuse for not doing so that he thought it would be an infringement of his brother's previous disclosure. The next question, whether there was anticipation by prior user of the machine must stand by itself apart from the specification altogether. Now he thought it was quite settled law that anticipation by a similar but useless machine would not invalidate a patent. A subsequent patentee who invented a useful machine and gave the world the benefit of it was not to have his rights taken away from him by some person coming forward who had invented a useless machine some years before and was not able to make anything of it. Nor, again, would an experimental machine that had been set aside after trial invalidate a subsequent patent. It did not require that the machine should have been in use down to the time of the patent being brought forward. It would do if it had been regularly used and put to useful work even if the use had been discontinued, but it must have been used in some way different from mere experiment. Varley never made a machine in which compound winding was practical; there was no user of it. He therefore submitted that Mr. Varley's machine was unworkable, and that there was no good ground for reduction of this patent of Mr. Brush's which had been found so successful.

Mr. GRAHAM MURRAY, for the pursuers, said he would begin with the commutator, upon which the Lord Ordinary was in his favour, and consider the alleged discrepancies between the provisional and the complete specifications. He did not think there was any difference between them as to the law of the matter. Mr. Jameson had quoted several cases. The only other case which required to be quoted was one recently decided, viz., Bailie *v.* Robertson. In that case Lord Blackburn gave a clear exposition of the law upon this matter. He thought they were clearly at one that what must be dirclosed in the provisional specification was the general nature of the invention, and what must be disclosed in the further specification was necessarily a sufficient way of carrying that out. But if he were able to show that the thing disclosed in the complete specification was a different invention from that in the provisional, then the patent was bad. His point depended upon a proper understanding of the functions of the commutator in one of Brush's machines, and their Lordships would see that this was an invention of a very useful electrical device. Their Lordships would also see that the divergence between the provisional specification and the final specification came to this, that all that was discovered, all that was claimed in the provisional specification were mere mechanical improvements having to do with the circumstances of the commutator. They should take the commutator as a known thing and they were giving a new mechanical construction to that commutator so that it would wear better. But when Hadden came to the final specification he had discovered something else and that something else he claimed, and thereby the electrical efficiency of the machine was enhanced. In the original specification a disclosure was made of what might be called a mechanical construction of the commutator and that alone. It was to construct commutators cylindrical, with an insulating hub or body, to which were attached metallic sub-segments placed in electrical connection with the general mechanism. They must take that, as everything else in the specification to a certain extent, with what they were told as to general knowledge, there was nothing new about making cylinders cylindrical. Commutators must always have some insulation.

Lord McLAREN: Does a hub mean a cylinder?

Mr. GRAHAM MURRAY: A boss, or hub, means the hub of a wheel.

Mr. JAMESON: A boss is the hub of the universe. (Laughter.)

Mr. MURRAY said that reading in that general knowledge he thought there was no doubt as to the construction of that, and as to what he had discovered. He had disclosed in his patent that he was to have sub-segments placed in electrical connection with his commutator and then metallic wearing segments detachably attached to sub-segments, but there was no intimation there of anything but a mechanical contrivance for making his commutators cylindrical with sub-segments and wearing segments detachably attached. When he came to the final specification he found something very different. Here he claimed the insulating segments, T, which were for the purpose of cutting the armature bobbins out of circuit when they were crossing the neutral or current-reversing points of the magnetic field. That was foreshadowing an invention that was not in any way disclosed in the provisional specification. Mr. Jameson had said that Mr. Brush had not claimed that this was a useful function, and that by segment T they only claimed a mechanical arrangement of the commutator. That was not what Mr. Brush said. Mr. Brush was asked about that. He was asked:—"Describe the operation of Hadden's commutators which are described in the third division of his specification, and claimed in claims 2, 3, 4, 5 and 6. (A.) The operation of the commutators described in the third division of the Hadden specification as claimed in claims 2, 3, 4, 5 and 6, is as follows:—First, it resolves the alternating currents that are generated in the armature into a continuous current in the field magnet coils and the external circuit. Second, it cuts opposite bobbins of the armature out of circuit and operation when they are at and sufficiently near the neutral or current reversing point in the field, leaving them in circuit and active only while they are effective in developing current. Third, the special construction described in division 3, and pointed out in claims 2, 3, 4, 5 and 6, enables the segments of the commutator as they become too much worn to be readily and cheaply renewed without disturbing any permanent mechanical or electrical connections, and without disintegrating the machine or commutator in any way.

"What is the purpose or object desired to be secured by the segments, T, in the fourth claim?—The segments, T, operate to so break and open the circuit of their associate armature bobbins that those bobbins shall be open circuited while they are passing through the neutral or current-reversing points of the field of the dynamo.

"State wherein the novelty of the subject matter of claim 4 consists.—The novelty of the subject matter of 4 consists in providing a dynamo commutator with segments having the following characteristic and function: They are metallic, like the electro-conducting segments of the commutator, thus forming a wearing surface corresponding to the general wearing surface of the rest of the commutator, whereby, as the Hadden patent states, 'I insure a uniformity of wear over the entire face of the commutator.' An insulating segment, T, as I have already explained, operates to cut out of circuit a pair of armature bobbins while they are passing through the neutral or current-reversing points of the field. This is its peculiar function.

"State wherein the utility of the subject matter of claim 4 consists.—The utility is twofold: First, in cutting out of circuit armature bobbins at a time when they are unable to contribute current to the general circuit, and thus prevent the discharge and waste of current from the active bobbins through them at such time. Second, in being made metallic and similar to conducting segments, whereby uneven wearing of the general commutator surface is avoided."

Mr. Murray proceeded to point out that Mr. Brush himself took this view of the matter, and accordingly the only question which seemed to remain was, if there was any indication at all of this in the provisional specification. That there was a novelty in this cutting out of the armatures, if they excepted Varley, there was no doubt. Prof. Silvanus Thompson in his evidence said, "With regard to the commutator, the insertion of metallic insulating segments is an important principle in detail. It is not the principle of working of the whole machine, but it helps undoubtedly to preserve the commutator from wearing to an untrue form. (Q.) Do you represent that, according to your view, the only invention disclosed and claimed by Brush there was the metallic insulating segment so far as it gave an insulating segment of cylindrical surface for the purpose of keeping cylindricity, and not so far as it provided a means of insulation? (A.) Both were novel points. I know of no case where an insulating body had previously been used in a commutator." Mr. Murray proceeded to say it was not probably a question of evidence at all, because the construction of the specification was for their Lordships, but no witness when he was asked to point out anywhere in the provisional specification a single passage or line that disclosed an invention by which this electrical result of cutting out the armature at a neutral point of the circuit was obtained could do so. The argument on the other side was not rested on the slightest attempt to show that the province of the insulating segment, T, was disclosed in the provisional specification. It was rather directed to try to prove that in the complete specification and claim Mr. Brush did not imply any such thing. But the person who must know best about it after all was Mr. Brush. But Mr. Brush did not see the danger of giving evidence about this long before the proof that was taken in the

Court of Session and before objection could be urged. At the same time it was clear that if it had not been for the defect in the original specification they should not have had the argument against it. Therefore upon this point he submitted that when the patent was looked at, and especially when the provisional specification was looked at, it was impossible not to see there was a meritorious invention in the complete specification and in the claim that was never adumbrated at all in the original specification.

The Court adjourned for the day.

The debate was resumed on Friday, May 30th.

Mr. GRAHAM MURRAY, for the pursuers, continuing his speech, said he had almost concluded what he had to say on the disconformity of Brush's provisional and completed specifications in regard to the commutator. He should now like to say a few words upon the claim itself, and to show that it was impossible for his friends on the other side to urge that that claim was not for an electrical contrivance for having an insulating segment, T. It was quite impossible for them to say that there was nothing but a claim for a mere mechanical contrivance. Therefore they tried to avoid it by enlarging the provisional and by lessening the final specification. In the final specification Brush claimed :—"A commutator cylinder consisting of an insulating hub or body to which are attached sub-segments placed in proper electrical connection with the general mechanism in which the commutator is employed and wearing segments detachably attached to said sub-segments." That claim was quite a proper echo of the provisional. The third claim was :—"The combination of sub-segments, R, wearing segments, S and T, and screws, K, substantially as and for the purposes shown in division three." That, again, was a claim that quite properly went along with the provisional, because it was a claim for a particular arrangement of the particular pieces which he had shown, as carrying out the general device of claim two. But then claim four was for "a commutator having metallic insulating segments, T, substantially as shown in division three." That claim was nonsense unless it was a claim for a segment, T, in its character of an insulating segment, because otherwise they had it already. It added nothing especially to the second claim, because it was not the segment itself; it was the commutator having metallic insulating segments, T.

The LORD PRESIDENT: You say the point in which it exceeds the provisional is the insulating segments, T.

Mr. MURRAY: Yes, the whole stress being upon the "insulating."

Lord McLAREN: He explains in the complete specification the electrical advantage of cutting off the current at these points. You say that this claim three is for an arrangement by which an electrical advantage is gained, which is not prefigured in the provisional. But suppose he had not set forth in the complete specification the electrical advantage, but had merely set it out as a mechanical arrangement, and then claimed it in the words that he has used, would that not have been a good claim as being one of the many mechanical ways in which the thing could be carried out.

Mr. MURRAY said he would not have written his fourth claim at all, because it would have been quite unnecessary. He would have covered everything in claims 2 and 3.

Lord McLAREN said the further consideration followed, whether if it would be a good claim, it could be vitiated by the fact that the specification also disclosed that electrical advantage.

Mr. MURRAY said it all depended on how they construed the claim. It was a very curious thing to disclose that electrical advantage and have a claim appropriate to it, and afterwards to say that they did not mean to claim the electrical advantage. There were two answers to the reclaimers' view upon that point, first, that claim four would be useless because they had already got it, and, secondly, that suppose claim four were read as not a claim of an electrical advantage at all, but a claim merely of a mechanical arrangement, then it was not patentable, because the only patent would be making the insulating segment, which had been of wood, metallic. Therefore he thought he put his friends on the other side in a dilemma on that point. Nobody reading that, and having read the description in the body of the specification before, could fail to see that what was being claimed there was an electrical device and not the mere mechanical device of having the segment made of metal instead of wood. Another point he made here was that the other side always read "insulating" as if it were "insulated," but it was the power of insulating that was described and claimed, not something insulated. That was all he had to say on the discrepancy between the provisional and final specification. But there remained the question whether Brush's commutator as described in that specification was not invalidated by prior use. Now there were what were known as the Manchester or Wilde's commutator. Evidence with regard to them he need not read for this very good reason, that he did not think the other side contended that he had not perfectly well proved that these commutators were used. Their point, and the Lord Ordinary's point, was that these commutators were not proper anticipations. He then showed two of the Manchester commutators, one with and the other without wearing segments. These commutators were taken off the shaft and the shaft itself was insulated from one half of the commutator and made to be in electrical connection with the other. That was to say instead of having a pair of wires, as in Brush's commutator, the metallic shaft of the machine itself served the electrical purpose of one wire, and one wire only was brought into electrical connection with the other half of the commutator. That was the difference upon which the Lord Ordinary had gone. The Lord Ordinary said in his note that with regard to Varley's and the Manchester commutators, he thought it might be said "that they are cylindrical, with metallic subsegments, having metallic wearing segments detachably attached. They also had an 'insulating body' or I should rather say 'insulating substance,' for the word body is ambiguous. Yet with all these points of similarity I do not regard them as anticipations of the defender's commutator. The insulating hub or body of the defender's commutator is the 'body' or basis on which his commutator is constructed—to which the various parts of his commutator are attached. This cannot be said of the Varley or Manchester commutator in which the insulating substance does not form the body or basis of the commutator at all, and insulates, not the whole commutator, but only one section of it." Now, his Lordship had made a slip there as regarded Varley's commutator. Varley's commutator was exactly like Brush's in the question of what parts were insulated and what were not; but with regard to the Manchester commutator the Lord Ordinary was right. As he had already explained, the commutator had got its electrical connection by only one wire, the purpose of the other wire being served by the shaft of the machine. In answer to the Lord Ordinary, he had to quote the testimony of the witness Silvanus Thompson, who, speaking of the Manchester commutator, said: "The use of the shaft in the machine as an electrical connection is a mere mechanical equivalent for a wire. It has been so used for long." Of course, if Silvanus Thomson was right in that, then the converse of that was equally true—that the wire was a mere mechanical equivalent for the shaft. Therefore that so called electrical difference was really no electrical difference at all. It would not enable the other side to support a new patent, if he had already discovered and used a commutator which had all the other parts exactly the same as Brush's, simply because, finding a commutator which used the shaft as one of the means of electrical connection with the armature, and a wire as the other means, they substituted therefore two wires and discarded the shaft altogether; the shaft being, of course, a very thick wire. He should like to put the matter in another way, which put the other side in a dilemma, looking to their argument. If they were so particular, in order to avoid by argument the discrepancy between the provisional and the complete specification, if they were so particular to say they denied that, so far as that commutator was concerned, that there was any electrical discovery whatever, then they must not blow hot and cold; and when he came to examine the Manchester commutator, they must not say: "True it is that your commutator is mechanically the same device, but, electrically considered, it works in rather a different way," because the communication was through the shaft instead of through a wire. They must surely stick to one interpretation of their final specification. Therefore, he submitted, on all these grounds, Wilde's commutator was a proper anticipation of Brush's.

Lord McLAREN: Suppose that Brush's commutator, instead of having for each circular section two wires led to the armature, had one of each pair of wires just screwed into the shaft, would the electrical effect be exactly the same.

Mr. MURRAY: Precisely; Silvanus Thompson put it very much in that way, for he said: "Taking a commutator that had eight wires there would be no difference electrically, if you used instead of eight wires, seven wires, and the shaft of the machine as the eighth." As he (Mr. Murray) had stated, the Lord Ordinary made a slip with regard to Varley's commutator, he meant the commutator as made on Varley's machine. During the proof they got leave to take off some of it, and they could see the place where it was prised off. He showed to the bench bits that had been taken off. The brass was "the sub-segment placed in electrical connection;" the iron was "the wearing segment, detachably attached;" and they could see the character of the little screw by which it was attached to the sub-segments. His friends on the other side made this point, that it could not be detachably attached when it required a hammer and chisel to take it off. It was true that it was taken off with a hammer and chisel under the inspection of Dr. Hopkinson; but it must be remembered that nobody knew anything about that machine. It had lain in Siebe and Gorman's and was covered with rust, and of course they had taken off the commutator with a cold chisel and a hammer. The Court, however, would have no difficulty in coming to the conclusion that if it had been known that it was fixed in the way it was there would have been no reason for hammering at all. All they needed to do was to cut a little nick in the head of the screw, put in a screwdriver and out with it. The only difference between the two was, that while in Brush's the screw head was allowed to remain on, in Varley's the screw head was cut off, and the top of the portion left was hammered into a sort of a rivet. That finished what he had to say about the commutators. Practically it came to three points—disconformity between the provisional and the final specification, anticipation by Wilde's commutator by public use, and anticipation by Varley's commutator by public use. He now passed to the more general and interesting part of the case, the question of compound winding. There were two points upon that—publication by Varley and prior user in respect of Varley's machine. The real truth was, that that invention was made for one purpose and which, by an extraordinary piece of good fortune was available afterwards for another purpose of infinitely greater importance. Whether Varley or Brush invented compound winding, it was clear to demonstration that neither Varley nor Brush saw the real merit or real importance of the invention which they made; and the great commercial value of the invention was due to something else entirely, which neither Varley nor Brush at that time knew anything about, and which was not discovered for some years afterwards. At that time, in 1876, the arc light was well known and was a practical success. The incandescent light was also known as a scientific fact, but they had not then discovered a substance which, at the point of resistance when incandescence was created, would not be consumed. Until the discovery of incandescent lamps there was no use for a dynamo that would maintain constant potential; but after the discovery of a suitable material for the incandescent light constant potential became a necessity. It was provable to demonstration that constant potentiality was no part of Brush's purview at the time that he entered into that patent. Nay, more, it was proved that constant potentiality did not depend upon compound winding; and although compound winding was a very convenient basis from which to start upon their search for constant potentiality, the true discovery of constant potentiality depended not upon compound winding, but upon certain other conditions altogether, which might really be got in a pure shunt machine just as much as in a compound wound machine, and which, if got in a compound wound machine, depended not upon the fact that it was a compound wound machine, but upon the proportion of resistance between the thickness of the two wires and the way they were employed. He would make that clear both by looking at Brush's patent itself, and also by quoting evidence. Indeed, he claimed to prove the whole of his case by the defenders' witnesses. What Brush really wanted at that time was the maintenance of a permanent field. At that time they were not at incandescent light, but at electro-plating, which was nothing more nor less than lighting in parallel; and Brush wanted to secure a machine that would always have a permanent field; in other words, that would maintain the passage of the electric current through the bath in the proper direction, and with sufficient force in order that it might not be overcome by the electricity sometimes generated by chemical action in the bath. Brush put that perfectly plainly in his specification. In that specification he said "other useful applications of a permanent field will readily suggest themselves," and it was upon these words that his friends upon the other side had now to hang constant potentiality. But there, Mr. Brush himself forsook them, for in his evidence in explaining the words "permanent field" he said they did not mean unvarying field, but a permanent field of unvarying polarity: and, again, "a field of constant polarity, and one not liable to reversal under normal conditions." That was as plain as plain could be that Mr. Brush himself did not think a permanent field meant anything to do with constant potentiality. But that matter did not rest there. He was glad and willing to take the other side's own witnesses, and no others, in support of his view. Silvanus Thompson said:—"(Q.) Do you take it that the object of Brush's invention is to give a constant potential? (A.) He never says so." Again he said that "he thought that the success as to constant potential depended rather upon the conditions of the individual machine than upon the question whether it was series shunt wound or shunt wound:" and, again, that "he should have expected much more specific instructions than were given in Brush's specification if the patent had been one for constant potential." Further on he gives a piece of very cogent evidence to the effect that as soon as a suitable incandescent lamp was discovered, it became desirable to have constant potential, that a great many methods were tried, and that most of the devices were prior to the discovery of these conditions of proportionate resistance and so on, which they now knew, and which ensured constant potential in a series shunt machine. He called that most cogent evidence, because it showed that there was Brush with that very machine, compound wound if they liked, at the the date when a suitable incandescent lamp having been found, constant potentiality was desirable, and yet it did not occur to him or any one to solve the question of constant potentiality by means of compound winding, because they tried some other plans. It was not until someone discovered "those conditions of proportionate resistance," that they were enabled to turn a simple series shunt machine into one that would ensure constant potential. That was a most eloquent commentary upon any attempt to show that Brush had reached constant potential at the time he took out his patent. He thought he had shown that as regarded constant potential, the real merit of the invention, was neither known to Brush nor to Varley He now came to Varley's patent, and there the question was whether Varley did, or did not, disclose compound winding. His friends on the other side had tried to read, or rather to misread, Varley's specification by the light of another specification of Varley in 1867. He did not think that was legitimate in the construction of Varley's specification in 1876. Varley was the first inventor of a self-exciting dynamo, and it was that machine of 1867 that got a prize at the Electrical Exhibition. All reference to that machine ought to be kept out of this case. Coming, then, to Varley's specification of 1876, they found that Varley gave a description of his machine; and it would be convenient if their lordships would follow the description upon the models upon the bench, because the cross-examination of the defenders' witnesses followed that line. Mr. Jameson had read the examination-in-chief of these witnesses, all of whom said the specification was misleading. He claimed to say that not one of them stuck to that position in cross-examination. They were forced to admit that the words there used were consistent and consistent alone with compound winding. Their lordships, however, would, after all, probably be more inclined to take their own view upon that than that of any of the witnesses, and, therefore, he asked their lordships to follow with him upon the model the precise phraseology, and see how inapplicable the language was to any other way than compound-winding.

Mr. Murray then, by the aid of models, described the three methods of winding—series, shunt, and series-shunt—and proceeded to say that Varley described his method of winding thus: "Part of the electricity developed by the machine is diverted to maintain the magnetism of the soft iron magnets." He paused then to say that that was evidently appropriate to describe either shunt proper or the shunt portion of a series shunt machine, because in both it was true that part of the electricity was diverted to maintain the magnetism of the magnets. "And the remaining portion is used to produce the electric light." Now, said his friends on the opposite side, "You must read in there 'is only used to produce the electric light,' because, as a matter of fact, in a compound wound machine the remaining portion of the electricity is used not only to produce the electric light but also to maintain the magnetism of the magnets." Leaving, that over in the mean time he went on: "There are several well-known ways of doings this, but the method I prefer is to wrap the soft iron magnets with two insulating wires, one having a larger resistance than the other." He paused there again, for here was the bottom of the fallacy upon which the defenders' witnesses proceeded. There were two ways in which the sentence, grammatically, could be read. One was: "There were several well-known ways of doings this, but the one well-known way that I prefer is so and so." All his friend's witnesses started by reading it in that way, and they said triumphantly that the only well-known ways were ways that did not include compound winding. But the other way in which the sentence could be read, and his way of reading it was:—"There are several well-known ways of doing this, but I show unto you a more excellent way, which is wrapping the two magnets with two wires." Grammatically speaking, he was free to admit, there was nothing to choose between the two, the use of the disjunctive, "but," being equally appropriate.

The Lord President: There is a change in the word "way." He uses "method."

Mr. Murray said that was in his favour. He did not think anyone had seen that hitherto, and he thanked his lordship for pointing it out. What was Varley's method? He wrapped the soft iron magnets with two insulating wires, one having a larger resistance than the other. It seemed to him perfectly clear that that sentence put out of the way either pure series or pure shunt; and for this reason, why have two wires when you only need one? They did not need to wrap the two magnets with two wires unless they were going to pass a current through them. There was a wild attempt on the part of Mr. Preece to represent that that might be done for the purpose of induction, but he had to discard the attempt. But then came a very important sentence. "The circuit of larger resistance is always closed, and the circuit of less resistance is used for the electric light." That was perfectly appropriate to series shunt. "The circuit of larger resistance is always closed," was absolutely true either of shunt or of series shunt. "The circuit of less resistance is used for the electric light." Here his friends on the other side wanted to read in the word "only." That necessitated them to say that that was pure shunt, because the circuit of less resistance was used not only for the electric light but also for the magnets. But then the next sentence drove them from their position: "When the electric light is being produced the greater portion of the electricity passes through the circuit of less resistance, which I term the electric light circuit, maintaining the magnetism of the magnets and producing the light." That clinched the whole concern, because it just left out the word "only" which his learned friend wanted read in. It would not be true, and could not be true of a shunt arrangement, because in a pure shunt arrangement the circuit of less resistance is maintaining the magnetism of the magnets, and therefore they could not read that sentence as consistent with any method of arrangement except compound winding. "When the electric circuit is open from any cause, the electricity developed passes through the circuit of greater resistance only," that was to say the shunt, "and maintains the magnetism of the magnets." How very clear all that became if they substituted the word "shunt" for "the circuit of greater resistance." Having read the specification in that way, he said that nothing could be clearer or plainer than that, and he never saw in his life a more absolutely unscientific spectacle than the defenders' witnesses presented in deliberately sitting down and determining not to understand the thing, in order to avoid the one conclusion to which in the end they were forced—namely, that that was series-shunt winding, and nothing else.

Lord McLaren: I suppose we must take it that the self excitation of the magnets by the machine was known at the date of this specification, although not widely known?

Mr. Murray: Yes.

Lord McLaren: The only question between you is whether this passage, which undoubtedly describes one form of compound winding, describes compound winding in which the wires that go round the magnets receive their electricity from a separate source or from the same source. There is no direct indication of a separate source.

Mr. Murray said he should be able to read evidence that would utterly drive separate excitation out of the question. He wanted first of all to show that the defenders' witnesses were really forced, in the end, to admit that his was the only clear construction. His point upon Varley's description was this, that if the blindest workman in the world did what Varley told him he would have compound winding in spite of himself, because they could not wind a machine in a way that would correspond to that direction without producing compound winding.

(To be continued.)

Crompton and Company v. Elieson Electric Company, Limited.

IN this action, which began on Wednesday last before Mr. Baron Huddleston and a special jury, the plaintiffs claimed to recover from the defendants a sum of £450 odd for certain goods supplied and work done for the defendants at their request. It was agreed during the trial that £384 was the amount to be paid the plaintiffs by the defendants. The defendants counter-claimed for damages, urging that in May, 1888, it was agreed between them and the plaintiffs—who at that time knew all about certain arrangements by the defendants with the North Metropolitan Tramways Company—that the plaintiffs should, for reward, undertake and be responsible to the defendants for the superintendence and erection of certain works and buildings, and the running arrangements in connection therewith, and should have the sole control and management of the same, and should exercise all due and reasonable care and skill in such management, and that the plaintiffs undertook to put the whole of the said works, buildings and plant into proper working order, and to do all things necessary to insure the proper working and running of the defendants' traction engines, and of the traffic on the North Metropolitan Tramway, so far as it depended upon the said engines, and that the plaintiffs thereupon, in pursuance of the said arrangement, entered upon such management and supervision of the said works, &c., and took possession thereof and assumed their whole control. The defendants alleged that in breach of this arrangement the plaintiffs were guilty of negligence in carrying out the same, and had so caused the defendants serious loss and damage, inasmuch as owing to such negligence the North Metropolitan Tramways Company discontinued the use of the defendants' electrical engines, and refused to continue the arrangements then subsisting between them and the defendants for the employment of such engines, and the defendants accordingly lost the profits and benefits which they would have derived by reason of such arrangements, and the works and buildings which they had erected at Ilford became useless. The plaintiffs denied the agreement as alleged by the defendants, but admitted that in May, 1888, they did agree to take the management of erecting and working the new depôt in Romford Road, Ilford, and to engage and pay the men, and in pursuance of such agreement that they did enter upon such undertaking. The plaintiffs denied that at this time they knew of the arrangements between the defendants and the North Metropolitan Tramways Company, as alleged. The plaintiffs further denied their negligence, and also that the defendants had sustained any damage whatever. It appeared that for some six months previous to May, 1888, the date of the agreement between the plaintiffs and the defendants, the defendants had been running their electrical engines upon a portion of the North Metropolitan Tramways Company's system with some success. In August, 1887, it being proposed to extend the use of their engines to other parts of that tramway company's system, the defendants for the time left off running their engines as before, with the intention of enlarging their works, &c., in that connection, and resuming the running again as soon as possible on the more extended basis. With that object the contract in dispute had been entered into by the plaintiffs and the defendants. On September 10th, 1888, the running of the defendants' engines was resumed, with the result that one of the engines broke down in the morning, owing, it was alleged by the defendants, to the plaintiffs' negligence in charging the accumulators, and on the same day two other engines broke wheels in going over the tramline points leading to the defendants' depôt. On the following day one of the engines, on being reversed, tore out several teeth in the rack gearing, and was completely disabled. On the following day no mishap occurred, but the defendants on that day received notice from the tramway company to cease running their engines on their system unless they were in a position to take up the entire responsibility of the motive power of their whole tram system. This they were not in a position to do, and the defendants' engines had not since been employed by the tramway company. It appeared that after the agreement between the plaintiffs and the defendants the former took over the management of all the defendants' works and plant in connection with their arrangements with the tramway company. The most important point in the case was, What was the relationship between the plaintiffs and the defendants under their agreement? On the one hand, the plaintiffs asserted that they were merely managers for the defendants in the sense of their foremen, and that consequently they could not be held liable for the negligence of their subordinates, who were really the servants of the defendants. The defendants, on the other hand, contended that under the agreement the plaintiffs contracted to take over the entire control, supervision, and management of all the defendants' works, &c., in connection with the defendants' arrangements with the tramway company, and that, this being so, they were liable for all acts of mismanagement by themselves or their servants. It was further urged that where an expert is employed to do work from which special damages are likely to follow, and is aware of all the particular circumstances of the case, he is liable for any such special damages. "Hadley *v.* Baxendale" (9 Ex.), "Boize *v.* Edwards" (*W.N.*, December 28th, 1889), and "Simpson *v.* North-Western Railway Company" (3 Q.B.D., 274) were cited in support of this contention. A great deal of evidence was adduced on both sides, and at the close of the case,

Mr. BARON HUDDLESTON, in summing up, told the jury that it had been admitted that the defendants owed the plaintiffs £384, and that therefore for that sum the plaintiffs were entitled to a verdict. The real question arose upon the defendants' counterclaim—viz., were the plaintiffs liable in damages to the defendants, and, if so, to what amount? In considering those questions they would have to decide what was the exact contract entered into between the plaintiffs and the defendants? Were the Cromptons merely managers to the defendants in the sense of a foreman or bailiff's position, or were they really in the position of contractors, taking over the entire management and control of this particular part of the defendants' business, and responsible for the negligence of the defendants' servants as if they were their own? That question really depended upon the view they took of the agreement between the plaintiffs and the defendants in May, 1888. This agreement could not, the learned Baron thought, be said to be in writing. He would, however, leave them to say whether it was in writing or not. If it were, it would be for him to interpret; if not, they would have to say what was the intention of the contracting parties. The second question in the case was that of negligence, which they would have to consider if they found that the plaintiffs were in the position of contractors, as explained, and not merely foremen. The learned Baron then referred the jury to the three heads of alleged negligence and the evidence thereon, and concluded by charging them upon the question of damages, explaining the doctrine of remote damages.

The jury retired to consider their verdict, and, after a considerable absence, they found a verdict for the defendants upon their counterclaim, and that the plaintiffs were contracting parties and guilty of negligence in respect of the accumulators and rack teeth, but not in the respect of the points. They assessed the damages at £184. They also found, as directed, for the plaintiffs on their claim for £384.

Judgment accordingly, and certificate for special jury.

Mr. Moulton, Q.C., and Mr. Graham appeared for the plaintiffs; and Mr. Finlay, Q.C., and Mr. Bousfield (instructed by Messrs. Vincent and Vincent) appeared for the defendants.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

(*Continued from page* 656.)

NATURE AND MODE OF SUPPLY.

In the old orders two systems were mentioned—viz., the "parallel system," and the "series system," meaning constant pressure and constant current systems respectively. Now no system is specified, except that it must be one approved by the Board of Trade. A new sub-section was added to this last year at the instance of the telephone companies, by agreement with the promoters, for the protection of the telephone circuits against interference by induction or otherwise, they being naturally rather alarmed at the proposed general use of alternating currents.

In the "Works" clauses, I need only mention that in the new model it is proposed to give powers for the construction of "street" boxes in place of "distributing" boxes. The special power taken is necessary, I believe, because these boxes come up to, and may come above, the surface of the ground. Also, that the prohibition of overhead wires, introduced last year, is inserted in the new model for companies, with the alteration that the time allowed for removal of existing overhead wires is reduced to one year. But they may be erected or continued in use with the consent of the local authority. This prohibitory section is based upon, and really does not go beyond, section 14 of the Act of 1882.

The "Compulsory Works" clauses provide generally that the undertakers shall do something substantial towards carrying out their undertaking within a specified time, under penalties of fine or revocation of the orders. The Board of Trade, however, must, in the case of a company, be moved to exercise its power of revocation by the local authority, except in the last model, where this has been altered; while in the case of a local authority being the undertakers, the Board of Trade has not hitherto, so far as I am aware, thought fit to exercise its power of revocation for non-performance of works within the required time, probably considering the plea that the practical knowledge and experience of electrical distribution was not sufficient to justify any expenditure of public funds, a valid one. This plea, however, is obviously daily diminishing in force. In nearly all orders the specified time within which mains have to be laid in certain streets is two years. It is three years in the Birmingham order of last year, but all streets within the area are included. The Liverpool order is also an exception.

In the old orders two years was also the period that had to elapse before any supply could be requisitioned in other streets, and six months more is allowed to comply with the requisition. In last year's London orders and the new forms, however, supply can be requisitioned after eighteen months, with six months for compliance; so that persons in streets not scheduled can get a supply at the same time as those in scheduled streets. Also, in the recent orders, as already mentioned, supply can be requisitioned for any part of the area included in the order; whereas in the old orders it could only be requisitioned for the A district.

There is a slight variation, too, in wording, which may be important, viz.: whereas in the old orders mains were to be laid *in* every street, now it is *throughout* every street.

The requisition to lay distributing mains in any street has to be signed by a number of persons, which number is a very variable quantity in different orders.

Thus in the old orders of 1883 it was two or more owners or occupiers in the case of an order given to a company or person, and the owners or occupiers of not less than one-fourth of the premises in the street in the case of a local authority. In the Chelsea order of 1886 it was six or more owners or occupiers.

Last year the Board of Trade reverted to the former practice both in the case of companies and local authorities, except in the Birmingham and Liverpool orders, where no power of requisitioning is given to owners. These two orders are very exceptional in respect of these clauses.

This year, in the model forms, which are not intended to apply to London, it is proposed to follow the precedent of the Chelsea order, and to require six signatures to a requisition, the number being the same both for local authority and company orders.

After the requisition clause follows a long clause intended to provide that the undertakers shall, if they so require, be guaranteed by the persons making the requisition a return for their outlay in laying the requisite mains of 20 per cent. per annum for three years in the old orders, two years in the London orders, and again three years in the new model orders.

After these "Compulsory Works" clauses come a few clauses headed "Maps," and then, in the old orders, "Regulations as to Supply on the Parallel System." These regulations are not inserted in any of the recent orders, but are issued separately with the safety regulations. Then we come to some clauses headed "Testing" in all orders up to this year; but in the new models an improved arrangement has been followed, and "Supply" comes next to "Works," which certainly seems a more logical sequence; also, the clauses applying to the appointment and duties of electric inspectors are now put under a separate heading.

Taking these clauses first, the appointment of electric inspectors is vested, in the case of all orders to companies, except the London Orders, in the local authority; in the London orders it is vested in the County Council; and in all existing local authority orders in a court of summary jurisdiction, moved either by a consumer or by the undertakers themselves. In the new model this appointment is vested in the Board of Trade. In case of the local authority not appointing an inspector, or imperfectly attending to inspectional duties, there is a provision in all company orders for appointment, in some cases by a magistrate, in others by the Board of Trade.

In the new model orders a clause has been added specifically stating that the Board of Trade may appoint an inspector for the purposes of any inquiry on an accident or as to safety. I think it is obvious that the Board of Trade has in any case, whether expressed in the order or not, the right to make inquiry as regards safety.

All local inspectors are to be paid by the local authority, or County Council for London; but fees may be charged by means of which part, at any rate, of the cost of inspection will be recouped.

Inspectors may be appointed from time to time for particular services, or the appointment may be continuous. It is rather difficult to see how this matter will work in small towns where there may be no resident electrician unconnected with the undertakers, or, at any rate, none who would care to undertake the job for such remuneration as could be offered without unduly increasing the cost of the supply, since the expense of inspections must in one way or another be borne by the consumers.

Probably one electrician will secure the appointment for several towns not very far apart, and reside in a convenient locality for his district. It will be something like the birth of a new species; and some follower of Darwin will, in the next century, write an exhaustive monograph on the genesis of the electric inspector, showing how he came to differentiate from ordinary mortals, how he gradually acquired an extra sense warning him against high pressure, &c.

The duties of electric inspectors are clearly defined in the new model orders, as follows:—

"The duties of an electric inspector under this order shall be as follows:

"(*a*) The inspection and testing, periodically and in special cases, of the undertakers' electric lines and works, and the supply of energy given by them;

"(*b*) The certifying and examination of meters; and,

"(*c*) Such other duties in relation to the undertaking as may be required of him under the provisions of this order, or of any regulations under this order."

The next clauses in the new models are headed "Testing and Inspection;" and this is an improvement on the old heading of "Testing" alone, since it is obvious that in the case of a network of mains a good deal may be found out by inspection that could hardly be arrived at by testing. These clauses have been greatly altered, and I would especially drawn attention to a new clause—

"40. An electric inspector, if and when required to do so by any consumer, shall from time to time, on payment by the consumer of the prescribed fee, test the variation of electric pressure at the consumer's terminals, or make such other inspection and testing of the service lines, apparatus, and works of the undertakers upon the consumer's premises as may be necessary for the purpose of determining whether the undertakers have complied with the provisions of this order, and the regulations and conditions subject to which they are for the time being authorised to supply energy;" which is, I think, very practical, and may have important results. This clause takes the place of the following in the existing orders:—

"35. Every electric inspector, if and when required to do so by any person supplied with energy by the undertakers, shall from time to time test for insulation and conductivity any service lines by which such energy is supplied, and the efficiency of any joints in such service lines, and make such other tests in relation to such service lines as may from time to time be approved of by the Board of Trade."

In all orders there is a clause providing for the establishment of testing stations at various points in the area, either by the undertakers or by the local authority. I am not aware that any such testing stations have yet been established; but I believe that in several districts in London they are to be established for one position, at any rate—at the office of the local authority. The practical use of these testing stations is obviously to obtain a record of the variations of pressure at different points in the system, and of the duration of any abnormal pressure or stoppage of supply. The best solution appears to be to have a recording voltmeter at each station, which might be made in the shape of a pillar box; and possibly an indicating voltmeter exhibiting the pressure at any time would be a welcome addition. I consider that the production of a thoroughly trustworthy recording voltmeter is distinctly a desideratum for the improvement of electric supply. There appear to be very few such instruments in use at the present time.

In all orders I think there is reserved an appeal to the Board of Trade against any report of any electric inspector. It is to be hoped that this power will be used with discretion, as the electrical staff of the Board of Trade is strictly limited at present.

Now, taking the "supply" clauses, we have, first, that any owner or occupier of premises situated within a certain distance of any district main can demand a supply. This distance is in the 1883 orders 25 yards; in the London orders and the new forms 50 yards. He may be required, however, to pay the cost of service lines beyond a distance of 30 feet in the old, 60 feet in the London and new model orders. He must name a maximum current in the old orders, or a maximum power in the new, so that the proper size of service lines may be laid, and this maximum must not be larger than what may reasonably be expected to be the consumption on the premises; and if afterwards he wishes to go beyond the declared maximum, he must be prepared to pay for any alteration of service lines or apparatus thereby rendered necessary.

The person requiring a supply must also be prepared to make a contract to take and pay for a supply for at least two years of sufficient amount to pay 20 per cent. on the outlay incurred by the undertakers.

Then follow provisos as regards security for payment, prohibition of improper use of the supply, and a very important one added last year, which I will read.

The "price" clauses have been considerably affected by the supply being now considered a supply of energy, and not, as formerly, of electricity. I will read the first clause as it stood in the old orders and in the London orders:—

"31. The undertakers may charge for electricity supplied by them to any consumer (otherwise than by agreement):—

"(1.) By the quantity of energy contained in such supply; or

"(2.) By the actual quantity of electricity so supplied; or, unless the Board of Trade from time to time otherwise direct,

"(3.) By the number of hours during which the supply of electricity is actually used by such consumer, and the maximum current with which he is for the time being entitled to be supplied."

"50. The undertakers may charge for energy supplied by them to any ordinary consumer (otherwise than by agreement):—

"(1.) By the actual quantity of energy so supplied; or

"(2.) By the electrical quantity contained in such supply; or, unless the Board of Trade from time to time otherwise direct,

"(3.) By the number of hours during which the supply of energy is actually used by such consumer, and the maximum power with which he is for the time being entitled to be supplied."

In the new models method (3) has been altered as follows:—

"32. The undertakers may charge for energy supplied by them to any ordinary consumer (otherwise than by agreement)—

"(1.) By the actual amount of energy so supplied; or,

"(2.) By the electrical quantity contained in such supply; or,

"(3.) By such other method as may for the time being be approved by the Board of Trade."

The reason for this is that the old method (3) is decidedly wasteful, and, if generally adopted, would lead to far more energy than was necessary being supplied from central stations. Except in special cases, such as lighting of shops and business premises, it should be noted that the consumers are free to make any agreement they prefer as to the price to be charged and the method, but they have a right to be charged in accordance with methods (1) or (2), and the undertakers are always bound by the undue preference clause.

The meter clauses have hardly been altered at all, and it is, in my opinion, proof of the very great care and acumen with which these clauses were originally drawn, so far back as the year 1883, that no really satisfactory improvement has yet been proposed. These clauses will repay very attentive study. They are sometimes looked upon as stumbling-blocks, and it is said that they are unintelligible, and that they won't work; but I am afraid that these difficulties are rather due to want of study and defects of meters than to the clauses themselves. They are too long to take in detail, but, roughly, the gist is as follows:—

Any number and description of meters may be used both by consumer and undertakers, but only one meter is to be used for ascertaining the value of the supply. This is to be a meter certified by an electric inspector appointed under the order. Note that it cannot be certified by anyone else. The inspector must certify three things—(1st) That the meter is of some construction and pattern approved by the Board of Trade; (2nd) that it has been fixed and connected to the service lines in some manner approved by the Board of Trade, which must, therefore, in approving any pattern of meter, prescribe in what way it is to be fixed and connected to the service lines; (3rd) that it is a correct meter; and, in making this last declaration, the inspector, in my opinion, may reasonably take account of and be guided by any mark or certificate attached to the meter showing that it has been thoroughly tested and found sufficiently accurate to be pronounced a correct meter in some standardising laboratory, or he may himself carry out the necessary tests in a laboratory. It is obvious that he cannot thoroughly test it in the consumer's cellar, and also that the words "a correct meter" cannot be held to be only applicable to a meter that was absolutely perfect throughout its range.

The undertakers are to supply the consumer, either by purchase or hire, with a meter on demand, and procure its certification. No consumer is allowed to connect or disconnect the meter used for ascertaining the value of the supply without giving 48 hours' notice to the undertakers, under penalty.

If this meter belongs to the consumer, he is to keep it in proper order, but if it is hired from the undertakers they must maintain it, and in either case they may remove it for testing, all expenses connected with the removal being paid by the consumer if the meter turns out to be faulty, and by the undertakers if it is in proper order; and any other meter or apparatus placed by the undertakers upon the consumer's premises for the purpose of ascertaining or regulating the supply of energy must be of some construction and pattern and connected in a manner approved by the Board of Trade.

The only other point in the orders of much electrical interest is the price schedule. In this the definition of the Board of Trade unit has remained unaltered, except the simplification of the wording. Last year there was, as you may remember, some agitation to have the amount of the unit increased tenfold. The point referred to your Council, who did not recommend the alteration, was and the Board of Trade very willingly left it as it was. Of course undertakers are at liberty to make agreements for a price per 10 units, provided that the charges do not exceed the rates laid down in this schedule.

In the London orders of last year there was added to the second section a proviso to enable the standard pressure on the mains to be taken into account in assessing the value of the supply where this pressure is a high pressure, and the energy is transformed; but in the new model this section has been much simplified by the introduction of a new term, viz., the declared pressure at the consumer's terminals, which it is proposed to deal with in the new regulations.

Safety Regulations.

These were embodied in the old orders, and were in great detail, such points as the distance apart of terminals, and the maximum current to be taken from any pair of terminals, being specified. The pressure on distributing mains and service lines was not to exceed 200 volts continuous or 100 alternating; and no portion of any electric line placed above ground, and not enclosed, was to be at a pressure from earth exceeding 200 volts.

The St. Austell license of 1885 is, I think, the first license or order in which separate regulations have been issued; and the same form has been used in the Kensington and Knightsbridge order of 1889 and the St. James's license of 1888, and nearly the same form in the Chelsea order of 1886. These are more general in character. The limit of low pressure has been raised to 300 volts continuous, while alternating currents are not to be used except with the approval of the Board of Trade, and under such further regulations as may be considered necessary.

A very important innovation has also been introduced in these regulations, providing that the undertakers shall cut off any consumer upon whose premises they find that a leakage exists having a resistance to earth of less than 5,000 ohms. This is to some extent a departure from the policy of the Board of Trade to leave the regulation of the circuits on private premises to the insurance companies; but, unfortunately, electricity does not conform to these arbitrary distinctions, and a bad leak on a consumer's premises is just as much a source of danger and difficulty as one on the main outside—in the case of direct supply systems at any rate.

The general regulations for overhead wires, made under section 4 of the Act of 1888, are pretty generally known at the present time, and I need not dwell upom them. As you are aware, they were thoroughly revised by your Council, who have also given their powerful assistance to the Board of Trade in the matter of some new proposed general regulations for undertakers of electrical supply, which, however, are still under discussion. The principal features of the new draft regulations are—(1) The division of the various systems of supply into three classes, viz., low pressure, high pressure, and extra high pressure; low pressure to extend to 300 volts continuous or 150 alternating; high pressure from above this to 3,000 volts, either continuous or alternating—that is, to as high a pressure as we have had practical experience of in distribution systems; extra high pressure, above 3,000 volts. (2) A general provision that where high-pressure conductors or apparatus are exposed in such positions as to be possibly touched by persons, or brought into contact with low-pressure conductors, they shall be entirely enclosed in strong metal casing efficiently connected to earth.

(To be concluded.)

NEW PATENTS—1890.

7853. "Improvements in welding metals electrically, and apparatus therefor." W. P. Thompson. (Communicated by C. L. Coffin, United States.) Dated May 20. *Complete.*

7867. "Improvements in electric motors." H. H. Lake. (Communicated by the Giant Electric Motor Company, United States.) Dated May 20. *Complete.*

7871. "Improvements in electrical signal circuits." O. W. Hart. Dated May 20. *Complete.*

7876. "Improvements in methods of and apparatus for melting, refining, and casting metals and other substances by electricity." H. H. Lake. (Communicated by E. A. Colby, United States.) Dated May 20. *Complete.*

7981. "Improvements in dynamos and electro-motors." E. Sechehaye. Dated May 22.

7988. "Improvements in welding metals electrically." C. L. Coffin. Dated May 22. *Complete.* [Date applied for under Patents Act, 1883, Sec. 103, 6th November, 1889, being date of application in United States.]

7989. "Improvements in welding metals by electricity." C. L. Coffin. Dated May 22. *Complete.* [Date applied for under Patents Act, 1883, Sec. 103, 12th November, 1889, being date of application in United States.]

7990. "Improvements in electric welding." C. L. Coffin. Dated May 22. *Complete.* [Date applied for under Patents Act, 1883, Sec. 103, 19th November, 1889, being date of application in United States.]

7991. "Improvements in electric welding." C. L. Coffin. Dated May 22. *Complete.* [Date applied for under Patents Act, 1883, Sec. 103, 19th November, 1889, being date of application in United States.]

7992. "Improvements in electric welding." C. L. Coffin. Dated May 22. *Complete.* [Date applied for under Patents Act, 1883, Sec. 103, 19th November, 1889, being date of application in United States.]

7993. "Method of welding metals electrically." C. L. Coffin. Dated May 22. *Complete.* [Date applied for under Patents Act, 1883, Sec. 103, 6th December, 1889, being date of application in United States.]

7994. "Method of welding metals electrically." C. L. Coffin. Dated May 22. *Complete.* [Date applied for under Patents Act, 1883, Sec. 103, 12th December, 1889, being date of application in United States.]

8031. "Improvements in and relating to printing-telegraphs, and to the distribution of news transmitted thereby." R. D. Radcliffe. Dated May 22.

8036. "An improved insulated electric conductor." R. W. Eddison. (Communicated by G. Niemetz, Austria.) Dated May 23.

8076. "Improvements in the distribution of electric energy." G. Wilkinson. Dated May 23.

8110. "Improvements in electric regulators and meters of which such regulators form a part." G. Forbes. Dated May 23.

8141. "A new electric lamp." H. G. Nichols. Dated May 24.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889.

5563. "Improvements in electric batteries." H. H. Lake. (Communicated from abroad by Lacombe & Co., of Paris.) Dated April 1. 8d. The main feature of the said invention consists in substituting for the ordinary porous pot or vessel containing the carbon electrode and the depolarising mixture, an annular vessel composed of a hollow cylinder of carbon and a hollow cylinder of porous material, having a base or flange which forms the bottom of the said vessel. In this vessel is placed a suitable depolarising mixture, and the cylinder and base of porous material are perforated to facilitate the circulation of the exciting liquid. 2 claims.

5615. "Improvements in the generation of electricity on railway trains, and in means to be used in connection therewith for heating and cooling trains." I. A. Timmis. Dated April 2. 6d. The objects of the invention are to drive a dynamo (or more than one) on a railway train economically and efficiently—either to charge accumulators (whether they are placed in one or some or all the vehicles) or to supply the current to light lamps or work a brake, or for other purposes. 1 claim.

5955. "Improved ceiling rose or connector for electrical circuits and for the suspension of electrical fittings." E. W. LANCASTER. Dated April 8. 6d. Claims:—1. A base of insulating material having a projecting piece fixed thereto, and provided with a method of fixing the cover to the base or projecting piece, substantially as described and illustrated. 2. A ceiling rose or connector of insulating material for electrical circuits having a projecting piece for passing the wires from an electrolier and pendant through the projecting piece (irrespective of the cover) in such a manner as to protect and insulate the wires from each other, substantially as described and illustrated. 3. A ceiling rose or connector of insulated material having a projecting piece through which the wires from a pendant or electrolier may pass to connecting piece, and having a pin bolt or pipe passing through the centre for supporting the weight of a pendant or electrolier, substantially as described and illustrated.

6021. "Improvements relating to dynamo-electric machines and electric motors." A. L. SHEPARD. Dated April 8. 8d. Relates to dynamo-electric machines and electric motors, and is designed to afford the means whereby the position of the brushes relatively to the commutator in a dynamo-electric machine or electric motor will be automatically regulated to suit varying conditions of the external circuit, so as to ensure the most efficient working of the machine, and to obviate or diminish the liability to sparking. 4 claims.

6063A. "Improvements in and relating to electric spark rupturing appliances." H. H. LAKE. (Communicated from abroad by Prof. Elihu Thomson, of America.) Dated April 9. 8d. The object of the invention is to increase the efficiency and certainty of operation of the arc rupturing devices by permitting them to be brought very close to the point where the arc may form, to which end a shield or septum of insulating material is applied between the opposed surfaces of the arc rupturing device and the electrodes or conducting bodies between which the arc to be ruptured is formed, thereby preventing an arc from forming at any other portion of the electrodes or conductors than those directly subject to the arc rupturing force, and permitting the arc rupturing device, when of conducting material, to be applied without danger of defective action very closely to the electrodes. 4 claims.

7138. "Improvements in and connected with electric glow lamps." A. W. FITCH. (A communication from abroad by R. O. G. Drummond, of Kimberley.) Dated April 29. 6d. Consists in the provision of a shield of porcelain or other insulating material, designed to prevent water from dripping on to the lamp and serving at the same time as a reflector. 2 claims.

7506. "Improvements in the electric lighting of railway trains." I. A. TIMMIS. Dated May 4. 8d. The objects of the invention are to lessen the weight of the apparatus, to economise the electric current, and to lessen the expense and to increase the light. 2 claims.

9496. "Improvements in the accumulation of electrical energy and apparatus therefor." F. MARX. Dated June 7. 8d. The inventor accumulates electrical energy in a liquid by using an apparatus in which the liquid is chemically changed through the action of an electric current; the accumulated energy in the said liquid being discharged by setting free the electric current in another apparatus. 3 claims.

11661. "Improvements in thermo-electric and furnace batteries." C. HUELSER. (A communication from abroad by H. Mestern, of Munich.) Dated July 22. 8d. Relates to improvements intended to serve as a supplement to the invention for "Improvements in thermo-electric and furnace batteries," described in the specification of Letters Patent No. 2,259, dated February 14th, A.D. 1888. 5 claims.

14991. "An electricity meter for alternating currents." O. T. BLATHY. Dated September 23. 11d. Claim: An electricity meter for alternating currents, consisting of a counter registering the revolutions of a disc or other solid of revolution caused to rotate by the inductive and dynamic action of two magnetic fields or groups of fields, independent from and not intersecting nor interfering with one another, the one field being excited by a coil supplied by the main current or a fraction thereof, or by a secondary current induced thereby, and the other field being excited by a coil of great self-induction supplied by a current shunted from the main current or by a secondary current induced by the shunted current, substantially as described.

16148. "Improvements in electric couplings, more especially for use in electric bell circuits and the like domestic purposes." H. STUDTE. Dated October 14. 6d. Relates to a conductor contact for house telegraphs and other electric conductors, by means of which dining and work tables, and the like, can be placed in connection with the house telegraph conductor, or other electric apparatus, in an easy and convenient manner. 2 claims.

18838. "Improvements in underground conduit systems 'for electric conductors.'" S. PITT. (A communication from abroad by W. H. Johnstone, of Philadelphia.) Dated November 23. 11d. Relates to a system of underground distribution of wires for telegraphy, telephony, electric lighting, and for all the purposes for which electricity may be applied. The invention comprehends certain improvements in the construction of the conduit whereby proper ducts are provided in a practical and convenient manner, and whereby at hand holes or distributing boxes a large number of exterior ducts may readily be reached for the purpose of making lateral connection and distribution for consumption circuits. Also certain improvements at the hand holes or distributing boxes whereby all the cables may readily be reached, connections made, and the lateral wires conveniently carried out through the lateral spigot openings. 10 claims.

19004. "Improvements in suspenders and holders for electric glow lamps." W. WHITE. Dated November 26. 6d. Relates to a simple and inexpensive construction of the suspenders and holders of electric glow lamps provided with means of keeping the two conductors separate until they pass out of the suspender and into the holder. 3 claims.

19892. "Improvements in machines or apparatus for welding metal by means of electricity." H. E. FOWLER. Dated December 10. 6d. The object of the invention is to provide a machine which shall form the weld by working the joint without removing any of the metal, and thereby to approximate more nearly, by the use of this machine, to the method of hand or power hammer welding. 3 claims.

20235. "An improved method of and means for the production of the grids of electric accumulators in which the bars narrow from each side inwards." E. CORRENS. Dated December 16. 6d. The moulding of the grids or supporting frames of electric accumulators in which the bars narrow from the two sides inwards presents great difficulties, as the cores must be larger towards the inside than are the clear spaces between the bars on the two outer sides, so that cores of such form cannot be removed bodily from the grid. For this reason the core for a grid must be in several parts. The invention is based on this principle. 4 claims.

20734. "Improvements in magneto-electric machines." R. HADDAN. (A communication from abroad by C. F. Gillette, of New York). Dated December 24. 8d. Relates to the form and construction of the various parts. 3 claims.

CORRESPONDENCE.

The Lane-Fox Patents.

I enclose for your information a copy of a letter which we are sending out to all undertakers using the Lane-Fox system of distribution, offering them terms for the use of the patents.

In respect of private installations a circular will shortly be issued in much the same words; but instead of the charges A, B and C, a payment of 3s. 6d. per 16 C.P. lamp yearly will be demanded.

C. A. Stephenson.

LANE-FOX ELECTRICAL COMPANY, LIMITED,
66, Victoria Street, Westminster, S.W.,
June 10th, 1890.

Dear Sir,—1.—You are doubtless aware that your company is making use of the Lane-Fox patent for electrical distribution, No. 3,988**, of 1878.

2.—This patent, together with all the Lane-Fox patents, are now held by this company.

3.—My object in writing is to inform you that this company is prepared to grant a licence to your company, as undertakers; and I have to offer the choice of the following methods of payment of royalty for the use of the patent.

(*a.*) By a payment of ½d. per Board of Trade unit supplied to consumers.

(*b.*) By a payment of 1/8d. (one-eighth of a penny) per Board of Trade unit supplied to consumers. Such payment to continue after the expiration of the patent for such a term as would render the payment equivalent to *a*, taking all risks into consideration.

(*c.*) By a capitalised sum, payable partly in cash, partly in shares of your company; the sum to be arrived at on the basis of *a*.

4.—On an agreement being entered into, we shall be prepared to give your company, as undertakers, an indemnity for having used the patents prior to December 31st, 1889.

5.—This company will also consider such an agreement as final, and will not make any further claim in respect of any patents for distribution, regulation, secondary batteries and motor-dynamo distribution, taken out by Mr. Lane-Fox during the years 1878 to 1883.

6.—You will understand that these terms are offered without prejudice; no period is at present definitely fixed within which we shall require your acceptance, but this company reserves to itself liberty to withdraw these proposals at any time after the 16th inst.

Your faithfully,

C. A. STEPHENSON, *Managing Director,*
Lane-Fox Electrical Company, Limited.

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WOODHOUSE & RAWSON UNITED, LD., See Page xi.

2671

TELEPHONE: 1833. TELEGRAMS: "INDICES," LONDON.

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1542

By Order of the Mortgagees.

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600 Light Dynamos	£200	each.
500 " "	£150	"
120 " "	£60	"
40 H.P. Marshall Compound Engine	£400	"
8 H.P. " Vertical "	£45	"

Prices of Boilers, Gas Engine, Arc Lamps, Cable, &c., on application to the LIVERPOOL ELECTRIC SUPPLY COMPANY, LIMITED, 15, Highfield Street, Liverpool.

3742

"INSTRUCTIONS FOR THE LAYING AND JOINTING OF UNDERGROUND ELECTRIC CABLES."—Profusely Illustrated.—Translated from the French of Dr. Francois Borel. The KINETIC ENGINEERING Co., 26, Norfolk Street London, W.C.

613

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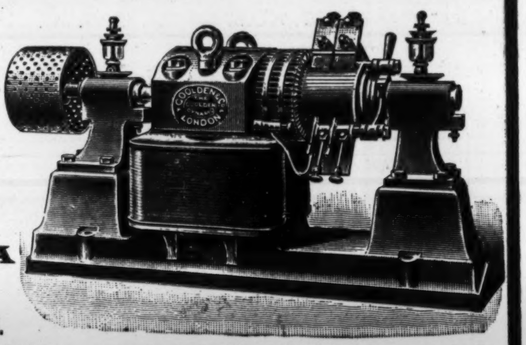

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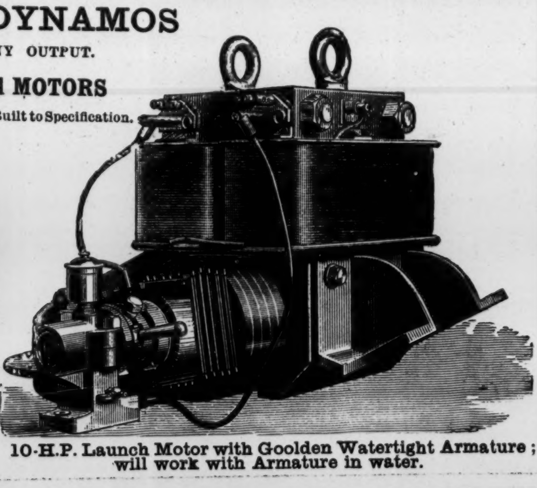

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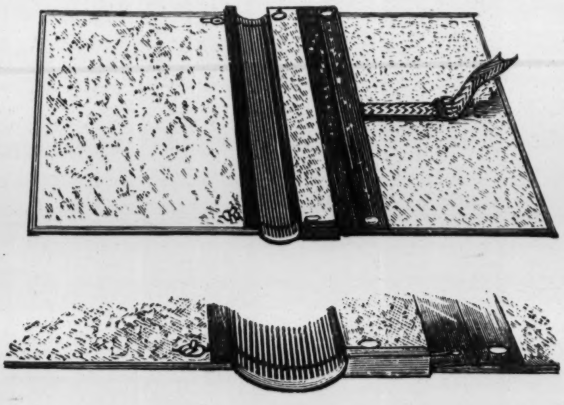

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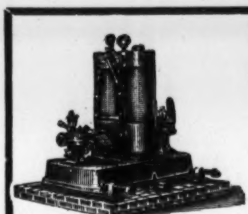

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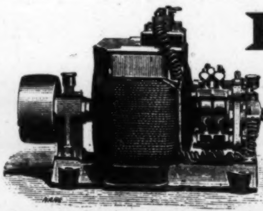

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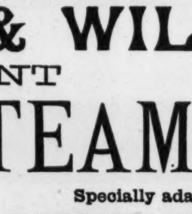

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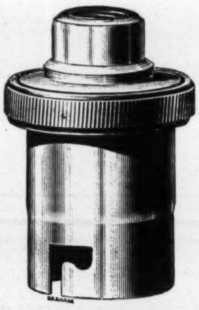

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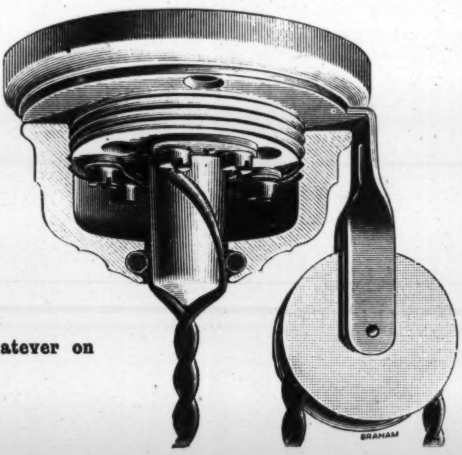

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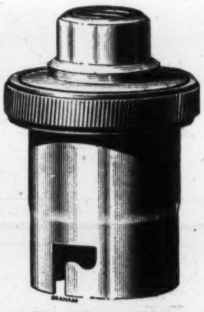

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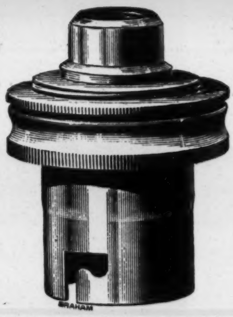

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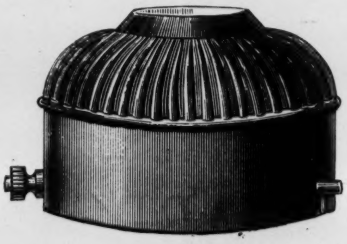

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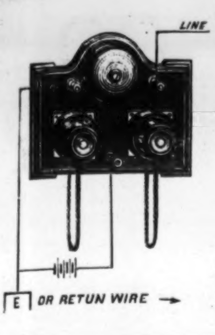

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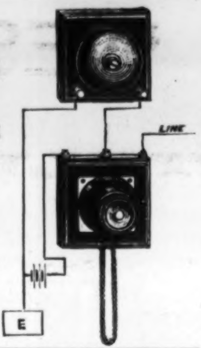

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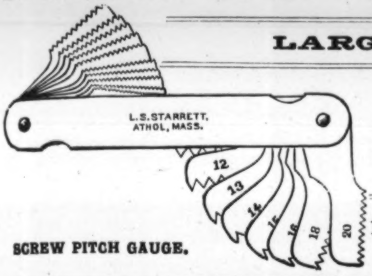

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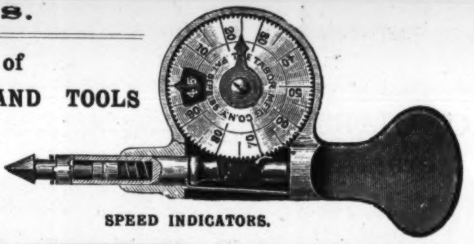

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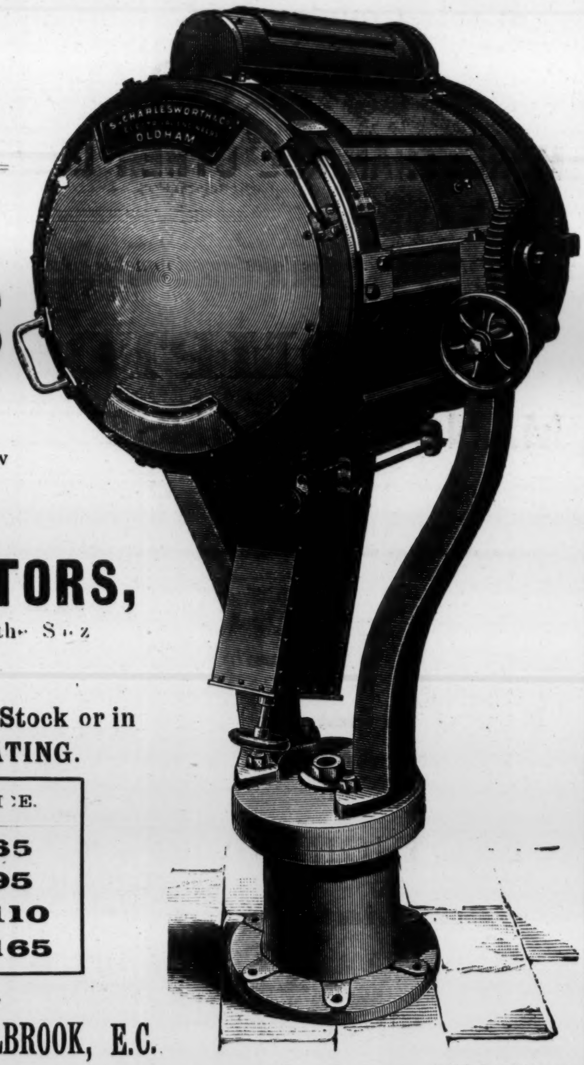

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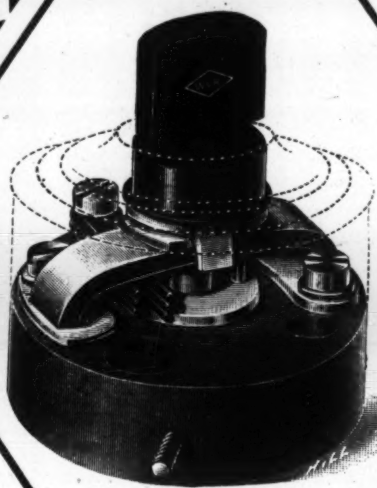

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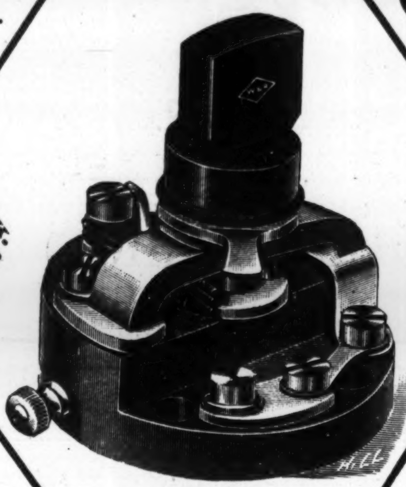

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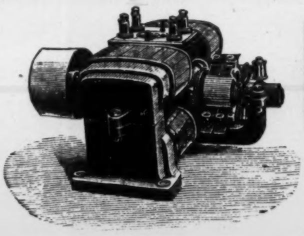

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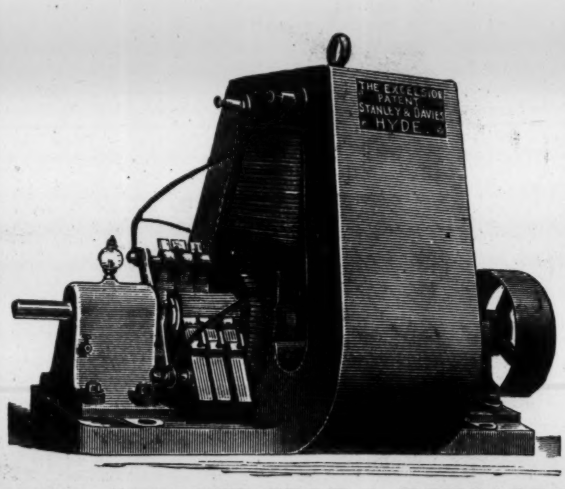
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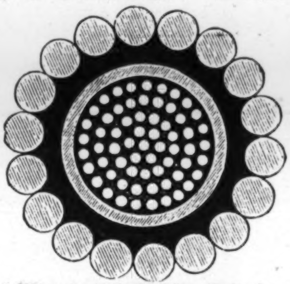

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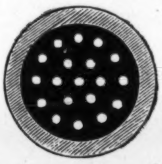

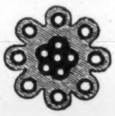

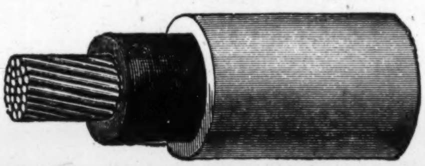

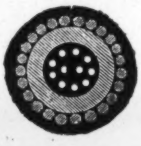

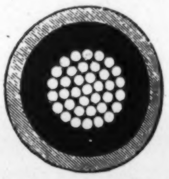

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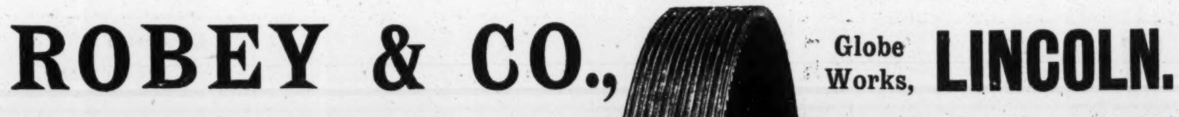

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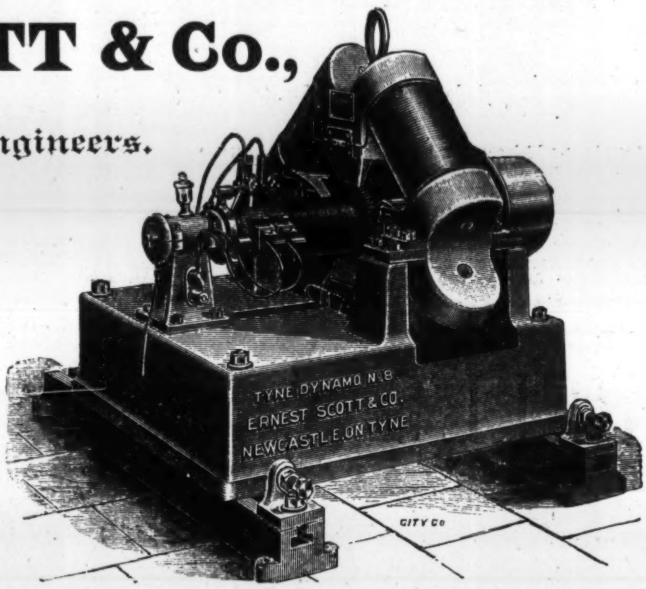

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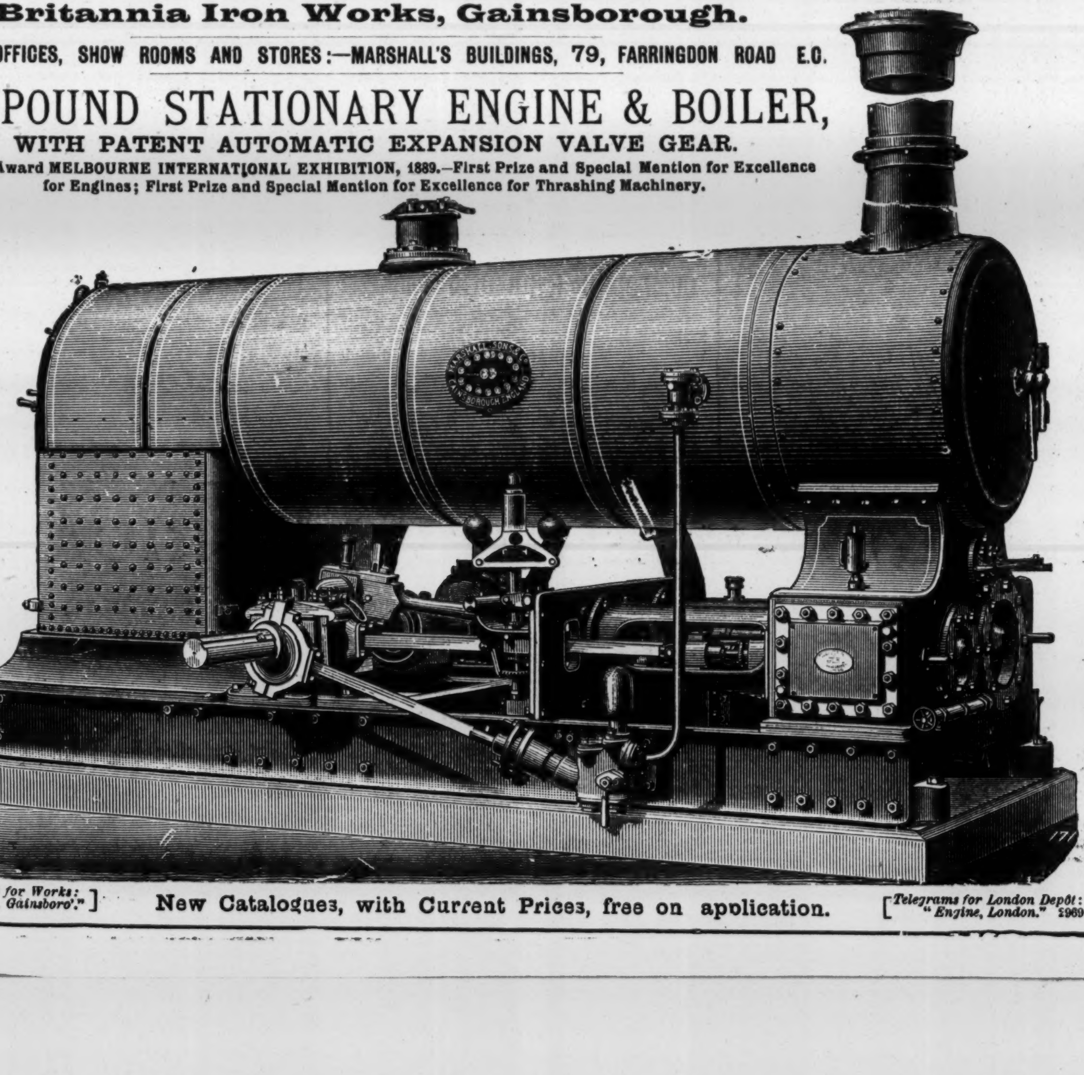

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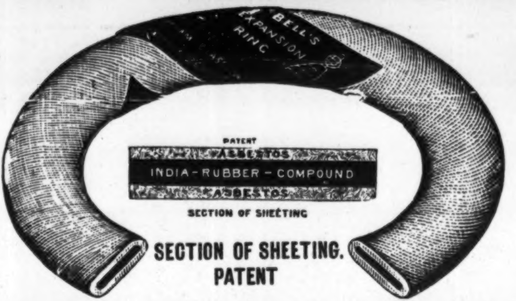

SECTION OF SHEETING.
PATENT

Made from 1-Ply for Cylinder and Faced Joints to any thickness for uneven surfaces.

The above, which can only be obtained from this house, is recognised as the Most Efficient and Economical Jointing Material in use. It is composed of a specially-prepared India-rubber Compound, protected by a covering of Vulcanised Asbestos Sheeting, as shown above, and as it is the only Jointing Material which adequately combines PERMANENT ELASTICITY WITH HEAT RESISTANCE, the advantages it possesses will at once be seen.

The Centre from which the requisite elasticity is obtained will adapt itself to uneven surfaces to which it may be applied, and allow the expansion and contraction to be fully taken up. The covering being of Asbestos Cloth, imparts a protection to the centre and so prolongs its elasticity. For Manhole, Mudhole, Steam Pipe, and Mash Tun Door Joints it is unequalled, and if applied as directed a ring can be used many times over.

BELL'S ASBESTOS Co., LTD.

TRADE MARK.
BELL'S ASBESTOS.
SOUTHWARK, LONDON, S.E.

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BELFAST, DUBLIN, ANTWERP, BERLIN,

DEPOTS:
HULL: Humber Dock Basin.
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AMSTERDAM: 264, N. Z. Voorburgwal.
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AGENTS.—BIRMINGHAM—BELL & Co., 7, John Bright Street. CARDIFF: BELL & Co., West Bute Street.

BELL'S ASBESTOS BOILER PRESERVATIVE

Will effectually keep Boilers clean and remove any Incrustation, without injury to the Boiler Plates or Fittings.

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TRADE MARK
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Is the BEST LOCOMOTIVE PACKING made.

BELL'S COMPOUND HYDRAULIC PACKING

IS SPECIALLY SUITED FOR HYDRAULIC MACHINERY, ACCUMULATORS, AND AMMONIA AND ALL PUMPS.

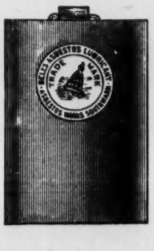
BELL'S ASBESTOS. NON-CONDUCTING COMPOSITION.

Will reduce loss by radiation, and saves 40 per cent. of fuel.

Is sent out dry in bags therefore cheaper than others sent out wet.

All bags are marked as above.

BELL'S ASBESTOS LUBRICANT.



Drums are marked as above.

Any customer receiving Oil sold as Bell's Asbestos Lubricant, & Cask, Drum, or Corks not marked as shown, is earnestly requested to forward us sample and particulars of where obtained.

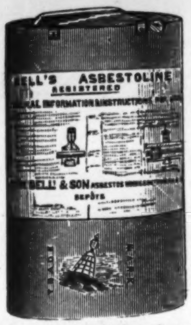
Every Cask is sent out as above.

ASBESTOS
BELL'S
LUBRICANT

All Corks are sealed as above.

BELL'S ASBESTOLINE.

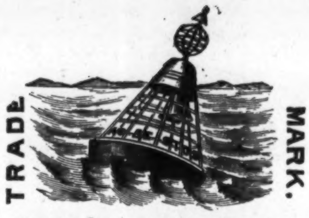
REGISTERED.



All kegs are labelled as above.

ADVANTAGES OF ASBESTOLINE.

ASBESTOLINE is the most efficient Lubricant for all bearings.
ASBESTOLINE is the cheapest Lubricant.
ASBESTOLINE saves from 50 to 90 per cent. of the Cost of Oil.
ASBESTOLINE is the Cleanest Lubricant.
ASBESTOLINE is favoured by Insurance Companies.
ASBESTOLINE is the most Inodorous Lubricant.
ASBESTOLINE is the safest Lubricant, its flashing point being 700 F.
ASBESTOLINE has beaten all other Lubricants in making trials.
ASBESTOLINE is applicable in and out doors in every climate.
ASBESTOLINE requires no special application.



BELL'S ASBESTOS.

CONSISTENCY OF ASBESTOLINE.

ASBESTOLINE, to meet all circumstances, is made in four degrees of consistency, A, B, C, and CC.

ASBESTOLINE A, is specially adapted to ordinary Land Engines and Machinery, in and out-door, in this country.

ASBESTOLINE B, a little more solid, is for use on Steamships in temperate climates, also on land when it is desirable to have Lubricant stiffer than A.

ASBESTOLINE C, is for use in tropical climates, both ashore and afloat. It is also invaluable in works in this country when the temperature is high.

ASBESTOLINE CC, is designed for use on calenders, paper machines, &c., where the bearings are heated by steam passing through, and sometimes is advantageously used instead of C.

The reputation of Asbestoline as a lubricant of the highest efficiency in every kind of machinery is established, and it has never been equalled by any other lubricant in the numerous cases of special difficulty in which the best oils are ineffectual. This reputation is growing daily, because it is **based on the experience of thousands of users** under the severest circumstances any lubricant has ever been subjected to, **and not on mere laboratory tests** and professional analysis of insignificant quantities. It is used with marked success in Steel and Iron Works, Collieries, Cotton and Wool Mills, and other Textile Manufactories. In Corn Mills it has proved invaluable on the roller and other modern machines. In Saw Mills, on Machines going up to 5,000 revolutions per minute, its work has never been approached by any other lubricant. On Electric Lighting Machinery, and in Steamships of all sizes throughout the world, the success of Asbestoline is unequalled. Many engines and machines of all descriptions give trouble and show bad results, both in working and wear, when the system of lubrication has not received due consideration. Engineering firms of the highest standing have given to it their powerful testimony and support.

SUPPLIED IN KEGS, 28 lbs., 56 lbs., or 112 lbs.

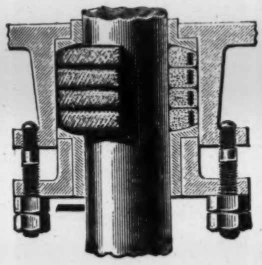
SPECIAL TERMS FOR LARGE QUANTITIES.

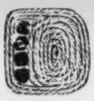
IMPORTANT TO EXPORT MERCHANTS.—One Pound of "Asbestoline" equals 2 gallons of Oil weighing 18 lbs. consequently the saving in freight is very considerable. Liberal Terms are conceded to Export Merchants.

BELL'S ASBESTOS

DAGGER PACKING

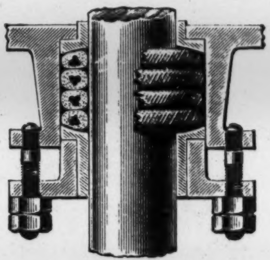
Patent.





SQUARE.

ROUND.



Every 10 feet has label as above, and bears our Trade Mark.

Under this registered title are included the inventions of Mr. Field, and experience has proved them to be **THE MOST EFFICIENT, DURABLE, AND ECONOMICAL PACKINGS** ever made. They constitute such a combination of Asbestos and India-rubber as secures the maximum of elasticity and heat resistance, and they are therefore **UNEQUALLED FOR EVERY KIND OF ENGINE.** These Packings are being universally used by most of the leading Steamship Companies throughout the world for ordinary Compound, Triple, and Quadruple Expansion Engines of the latest type. These Packings are composed of Rolled Asbestos Cloth, but the India-rubber is placed in two forms to suit various cases.

☞ **In ordering, state whether square or round required.** ☜

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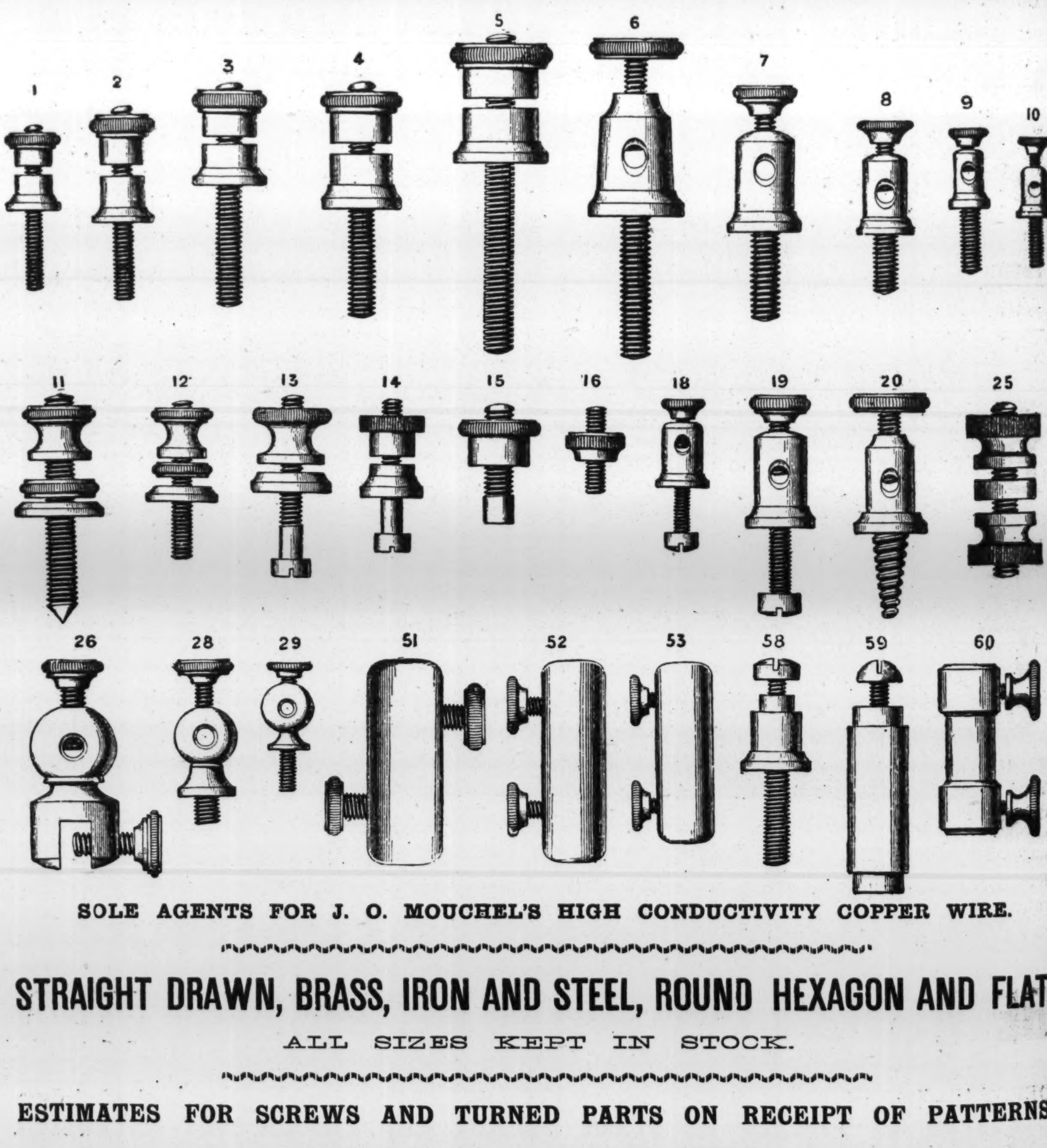

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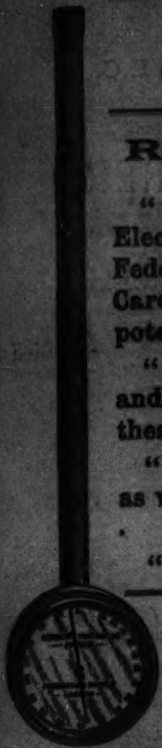

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Printed by E. KNIGHT, 18 and 19, Middle Street, E.C., and Published by the Proprietors, H. ALABASTER, GATEHOUSE & Co., at 22, Paternoster Row, London.